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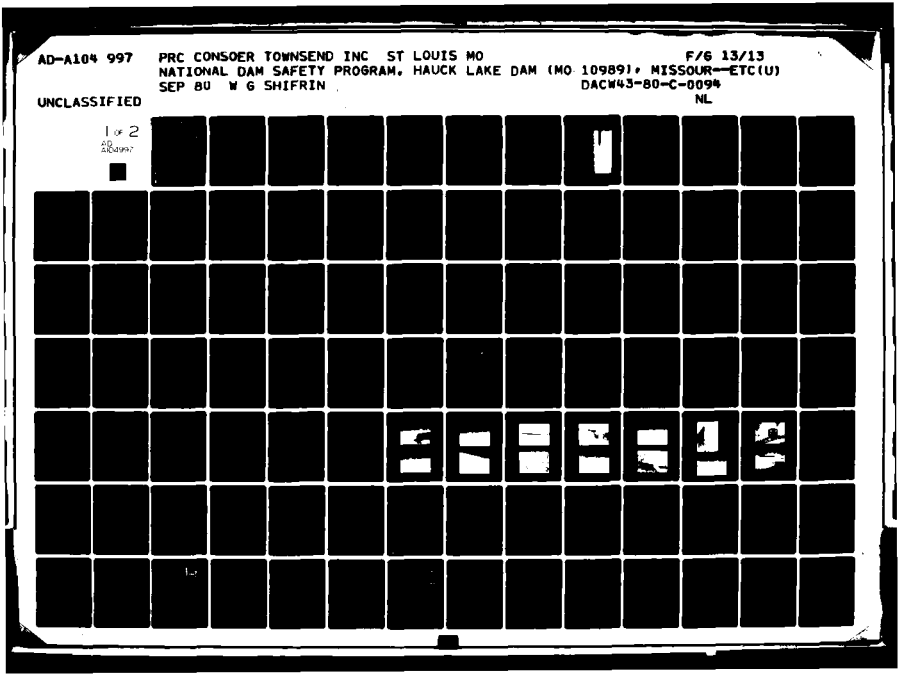

LEVEL II

(1)

MISSOURI · KANSAS CITY RIVER BASIN

HAUCK LAKE DAM
CALLAWAY COUNTY, MISSOURI
MO. 10989

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

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PREPARED BY: U. S. ARMY ENGINEER DISTRICT, ST. LOUIS

FOR: STATE OF MISSOURI

SEPTEMBER, 1980

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REPORT DOCUMENTATION PAGE

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1. REPORT NUMBER	2. GOVT ACCESSION NO. AD-A104997
3. RECIPIENT'S CATALOG NUMBER	
4. TITLE *(and Subtitle)* Phase I Dam Inspection Report National Dam Safety Program Hauck Lake Dam (MO 10989) Callaway County, Missouri	5. TYPE OF REPORT & PERIOD COVERED Final Report.
	6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Consoer, Townsend and Associates, Ltd.	8. CONTRACT OR GRANT NUMBER(s) DACW43-80-C-0094
9. PERFORMING ORGANIZATION NAME AND ADDRESS U.S. Army Engineer District, St. Louis Dam Inventory and Inspection Section, LMSED-PD 210 Tucker Blvd., North, St. Louis, Mo. 63101	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS U.S. Army Engineer District, St. Louis Dam Inventory and Inspection Section, LMSED-PD 210 Tucker Blvd., North, St. Louis, Mo. 63101	12. REPORT DATE Sept[illegible]980
	13. NUMBER OF PAGES Approximately 120
14. MONITORING AGENCY NAME & ADDRESS *(If different from Controlling Office)* National Dam Safety Program. Hauck Lake Dam (MO 10989), Missouri - Kansas City River Basin, Callaway County, Missouri. Phase I Inspection Report.	15. SECURITY CLASS. *(of this report)* UNCLASSIFIED
	15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRI

Approved for release; distribution unlimited.

17. DISTRIBUTION STATEMENT *(of the abstract entered in Block 20, if different from Report)*

18. SUPPLEMENTARY NOTES

19. KEY WORDS *(Continue on reverse side if necessary and identify by block number)*

Dam Safety, Lake, Dam Inspection, Private Dams

20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

This report was prepared under the National Program of Inspection of Non-Federal Dams. This report assesses the general condition of the dam with respect to safety, based on available data and on visual inspection, to determine if the dam poses hazards to human life or property.

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DEPARTMENT OF THE ARMY
ST. LOUIS DISTRICT, CORPS OF ENGINEERS
210 TUCKER BOULEVARD, NORTH
ST. LOUIS, MISSOURI 63101

REPLY TO ATTENTION OF

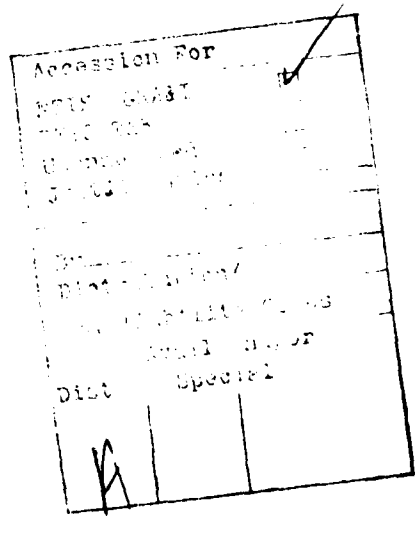
SUBJECT: Hauck Lake Dam (Mo. 10989) Phase I Inspection Report

This report presents the results of field inspection and evaluation of the Hauck Lake Dam (Mo. 10989).

It was prepared under the National Program of Inspection of Non-Federal Dams.

SUBMITTED BY: SIGNED — Chief, Engineering Division — 21 OCT 1980 — Date

APPROVED BY: SIGNED — Colonel, CE, District Engineer — 21 OCT 1980 — Date



HAUCK LAKE DAM
CALLAWAY COUNTY, MISSOURI

MISSOURI INVENTORY NO. 10989

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

PREPARED BY
CONSOER, TOWNSEND AND ASSOCIATES, LTD.
ST. LOUIS, MISSOURI
AND
PRC ENGINEERING CONSULTANTS, INC.
ENGLEWOOD, COLORADO
A JOINT VENTURE

UNDER DIRECTION OF
ST. LOUIS DISTRICT, CORPS OF ENGINEERS
FOR
GOVERNOR OF MISSOURI

SEPTEMBER 1980

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

Name of Dam: Hauck Lake Dam, Missouri Inv. No. 10989
State Located: Missouri
County Located: Callaway
Stream: An unnamed tributary of Stinson Creek
Date of Inspection: June 4, 1980

Assessment of General Condition

Hauck Lake Dam was inspected by the engineering firms of Consoer, Townsend and Associates, Ltd. and PRC Engineering Consultants, Inc. (A Joint Venture) of St. Louis, Missouri according to the U. S. Army Corps of Engineers "Engineer Regulation No. 1110-2-106" and additional guidelines furnished by the St. Louis District of the Corps of Engineers. Based upon the criteria in the guidelines, the dam is in the high hazard potential classification, which means that loss of life and appreciable property damage could occur in the event of failure of the dam. Within the estimated damage zone of four miles downstream of the dam are six dwellings, one building, a junkyard, a shed, a school and a park, all of which may be subjected to flooding, with possible damage and/or destruction, and loss of life. Hauck Lake Dam is in the small size classification since it is less than 40 feet in height and impounds less than 1,000 acre-feet of water.

Our inspection and evaluation indicate that the reservoir/spillway system of Hauck Lake Dam does meet the criteria set forth in the guidelines for a dam having the above size and hazard potential. Hauck Lake Dam being a small size dam with a high hazard

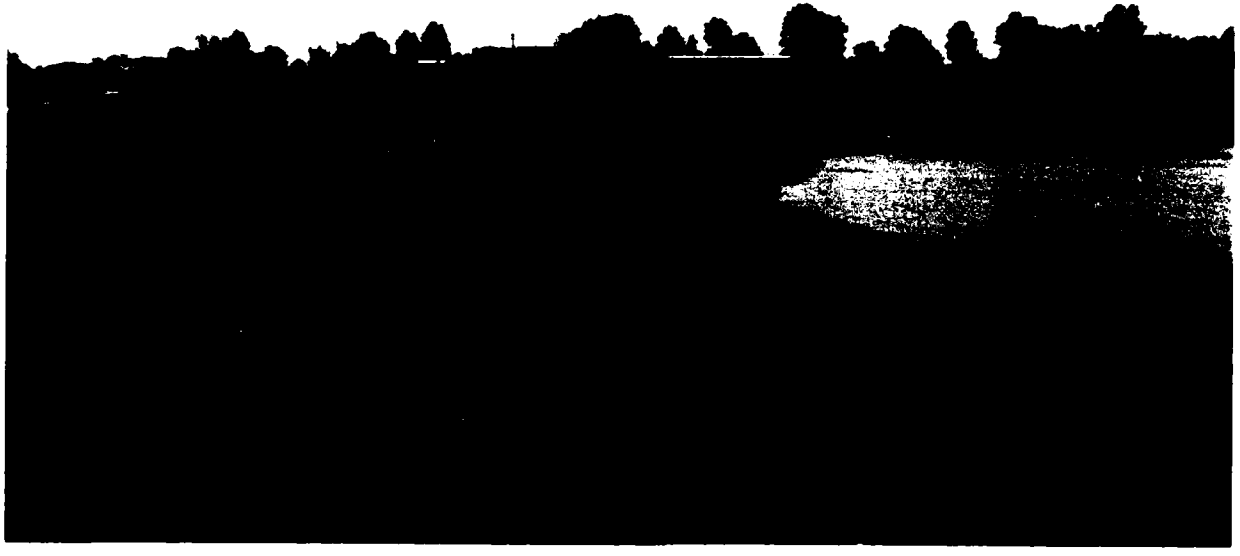
potential is required by the guidelines to be able to pass from one-half of the Probable Maximum Flood to the Probable Maximum Flood (PMF) without overtopping the dam. Nevertheless, considering the number of inhabited dwellings, the school and the park, located downstream of the dam, the PMF is considered the appropriate spillway design flood for Hauck Lake Dam. It was determined that the reservoir/spillway system can accommodate approximately 60 percent of the Probable Maximum Flood before overtopping of the dam occurs. Therefore, the reservoir/spillway system is considered to be inadequate. Our evaluation also indicates that the reservoir/spillway system will accommodate the one-percent chance flood (100-year flood) without overtopping the dam.

The Probable Maximum Flood is defined as the flood discharge that may be expected from the most severe combination of critical meteorological and hydrologic conditions that are reasonably possible in the region.

Hauck Lake Dam and its appurtenant structures are in fair condition. However, some deficiencies were noted by the inspection team which could affect the safety of the dam and appurtenant structures. These items are as follows: possible seepage at the toe of the dam, the wave erosion on the upstream berm, cracks on the top of the dam, rodent activity on the embankment and on the emergency spillway training berm, some minor surface erosion on the embankment slopes, the need for proper maintenance of the vegetation on the embankment, the accumulation of driftwood near the emergency spillway, the lack of adequate erosion protection in the emergency spillway channel, possible leakage along the principal spillway pipe, a need for periodic inspection by a qualified engineer and a lack of a maintenance schedule. The lack of seepage and stability analyses on record is also a deficiency that should be corrected.

It is recommended that the owner take action to correct or control the several deficiencies described above in the near future.

Walter G. Shifrin, P.E.



Overview of Hauck Lake Dam

NATIONAL DAM SAFETY PROGRAM

HAUCK LAKE DAM, I.D. No. 10989

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PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

HAUCK LAKE DAM, Missouri Inv. No. 10989

SECTION 1: PROJECT INFORMATION

1.1 General

a. Authority

The Dam Inspection Act, Public Law 92-367 of August, 1972, authorizes the Secretary of the Army, through the Corps of Engineers, to initiate a national program of dam inspections. Inspection for Hauck Lake Dam was carried out under Contract DACW 43-80-C-0094 between the Department of the Army, St. Louis District, Corps of Engineers, and the engineering firms of Consoer, Townsend & Associates, Ltd., and PRC Engineering Consultants, Inc. (A Joint Venture), of St. Louis, Missouri.

b. Purpose of Inspection

The visual inspection of Hauck Lake Dam was made on June 4, 1980. The purpose of the inspection was to make a general assessment regarding the structural integrity and operational adequacy of the dam embankment and its appurtenant structures.

c. Scope of Report

This report summarizes available pertinent data relating to the project, provides a summary of visual observations made during the field inspection, gives an assessment of hydrologic and hydraulic conditions at the site, presents an evaluation of the

structural adequacy of the various project features and appraises the general condition of the dam with respect to safety.

Subsurface investigations, laboratory testing and detailed analyses were not within the scope of this study. No warranty as to the absolute safety of the project features is implied by the conclusions presented in this report.

It should be noted that in this report the reference to the left or right abutments is viewed as looking downstream. Where left abutment or left side of the dam is used in this report, this also refers to the north abutment or side, and right to the south abutment or side.

d. Evaluation Criteria

The inspection and evaluation of the dam is performed in accordance with the U.S. Army Corps of Engineers "Engineer Regulation No. 1110-2-106" and additional guidelines furnished by the St. Louis District office of the Corps of Engineers for Phase 1 Dam Inspection.

1.2 Description of the Project

a. Description of Dam and Appurtenances

The following description is based upon observations and measurements made during the visual inspection. Two design drawings were located and are included as part of this report (see Plates 4 and 5). Any discrepancies between our field notes and the drawings are noted in Section 2.1 in this report. No major discrepancies were observed.

The dam is an earthfill structure between earth abutments. A plan and elevation of the dam is shown on Plate 2, and Photos 1 through 3 show views of the dam. The dam consists of two straight segments of embankment angled at approximately 15 degrees to each other and connected by a smooth curve. The major portion of the embankment has a bearing of approximately N 10° W and an axis length of 358 feet between the emergency spillway and the point of intersection of the two segments. The other portion has a bearing of approximately N 25° W and an axis length of 218 feet between the point of intersection of the two segments and the left abutment. The top of dam has a width of 12 feet and a total length of 576 feet between the emergency spillway and the left abutment. The top of dam was measured as level and has the assumed elevation of 842 feet above mean sea level (M.S.L.) The maximum structural height of the dam was measured to be 23 feet. A berm, varying in width from 5 to 10 feet, was constructed on the upstream slope 3.25 feet below the top of dam. The berm sloped down towards the reservoir on an average of 7.5 percent. The upstream slope was measured as 1 vertical to 2.5 horizontal (1V to 2.5H) from the top of dam to the berm and nearly vertical from the berm to the water surface. The downstream slope was measured to be 1V to 2H.

The dam was constructed with a double spillway system; the first is considered the principal spillway and operates as a closed conduit when flowing full, and the second is considered the emergency spillway and operates as an open channel.

The principal spillway was assembled from lengths of steel pipe welded together and laid through the embankment on a grade of 10 percent. Approximately 90 feet of pipe was placed on a bearing of N 63° E through the major portion of the embankment. The inside diameter of the pipe was measured as 10.5 inches. The drawings also reveal the locations of two or three metal anti-seepage collars as starting 15 feet from the beginning of the pipe and using a 15 foot spacing; the collars were to be a minimum of 5-foot square. The inlet for this spillway pipe, which is located

about 220 feet to the left of the emergency spillway, consists of a vertical, 21-inch inside diameter, 10-foot long welded steel standpipe. The standpipe rises into the berm area and has a crest elevation of 838 feet above M.S.L. An anti-vortex device approximately 3.5 feet long and 1 foot high, is fixed across the inlet (see Photo 6). Water flowing through the pipe would outlet into a discharge pool after a vertical fall of about two feet (see Photo 7).

The emergency spillway channel, which is cut into the right side of the dam, has a 55-foot top width, a 23-foot bottom width, and side slopes of approximately 1V to 6H. The crest of the spillway is 2.6 feet lower than the top of dam and about 1.4 feet higher than the principal spillway crest. As water progresses over the crest, (the crest invert is level for 34 feet) it flows into a large discharge channel with an 18 percent slope, before emptying into the County Highway F drainage channel (see Photo overview). A berm was constructed to form the left side of the discharge channel (see Photo 3). The discharge channel is earthen with a swale bottom and the highway drainage channel has a concrete lining (see Photo 9 and overview). Eventually, the excess flow from the emergency spillway is directed under the above mentioned highway via a 4-foot by 5-foot concrete box culvert (see Photo 11).

No low level drains or outlet works were provided for this dam.

b. Location

Hauck Lake Dam is located in Callaway County of the State of Missouri on an unnamed tributary of Stinson Creek, about 2 miles west of the city of Fulton. The axis of the dam is situated parallel to and approximately 200 feet southwest of County Highway F. The dam is located in the northwest quadrant of Section 18 of Range 9 West, Township 47 North as shown on the Fulton, Missouri Quandrangle (7.5 minute series) sheet.

Hauck Lake Dam impounds less than 1000 acre-feet and more than 50 acre-feet which classifies it as a "small" size dam. However, the maximum structural height of the dam is less than 25 feet which is the minimum requirement for a structure to be classified as a dam. Nevertheless, the size classification is determined by either the storage or height, whichever gives the larger size category. Therefore, the size classification is determined to fall within the "small" category according to the "Engineer Regulation No. 1110-2-106, Appendix D" by the U.S. Department of the Army, Office of the Chief Engineer.

d. Hazard Classification

The dam has been classified as having a "high" hazard potential in the National Inventory of Dams, on the basis that in the event of failure of the dam or its appurtenances, excessive damage could occur to downstream property, together with the possibility of the loss of life. From a visual inspection of the downstream area, our findings concur with this classification. There are six dwellings, one building, two sheds, one school, a junkyard and a park within the estimated damage zone, which extends approximately four miles downstream of the dam (see Photos 13 and 14).

e. Ownership

Hauck Lake Dam is owned privately by Mr. Gordon K. Hauck. The mailing address is as follows: Mr. Gordon K. Hauck, R.R. 4, Fulton, Missouri, 65251.

f. Purpose of Dam

The dam was built primarily for recreational purposes.

g. Design and Construction History

Hauck Lake Dam was designed by the Soil Conservation Service of Callaway County, Missouri in 1973. According to Mr. Hauck, the dam was built in 1974 by Leroy Garriot Excavation Company of Fulton, Missouri.

h. Normal Operational Procedures

Normal procedure at Hauck Lake Dam is to allow the reservoir to remain as full as possible while the water level is controlled by rainfall, runoff, evaporation and the elevation of the principal spillway crest.

1.3 Pertinent Data

a. Drainage Area (square miles):. 0.15

b. Discharge at Damsite

Estimated experienced maximum flood (cfs): . . . . . Unknown

Estimated ungated spillway capacity with reservoir at top of dam elevation (cfs): 418

c. Elevation (Feet above MSL)

Top of dam . . . . . 842.0 (Assumed)

Spillway crest:

Principal Spillway 838.0

Emergency Spillway 839.4

Normal Pool: 838.0

Maximum Experienced Pool:. . . . . Unknown

Observed Pool: 837.2

d. Reservoir

Length of pool with water surface at top of dam elevation (feet):. 1100

e. Storage (Acre-Feet)

Top of dam 176

Spillway crest:

Principal Spillway 104

Emergency Spillway 131

Normal Pool: 104

Maximum Experienced Pool:. . . . . Unknown

Observed Pool: 86

f. Reservoir Surfaces (Acres)

Top of dam 21

Spillway crest:

Principal Spillway 15

Emergency Spillway	17
Normal Pool:	15
Maximum Experienced Pool:	Unknown
Observed Pool:	14

g. Dam

Type.	Earthfill
Length:	576 feet
Structural Height:	23 feet
Hydraulic Height:	23 feet
Top width:	12 feet
Side slopes:	
Downstream	1V to 2H (measured)
Upstream	1V to 2.5H (from the top of dam to edge of the berm) and near vertical (from the berm to the water surface) (measured)
Zoning:	Homogenous
Impervious core:	NA
Cutoff:	Unknown
Grout curtain:	Unknown
Volume:	14,862 cu.yds. (from design drawing)

h. Diversion and Regulating Tunnel . . . . . None

i. Spillway

Type:	
Principal Spillway	Drop inlet, uncontrolled
Emergency Spillway	Earthcut channel, uncontrolled
Length of crest:	
Principal Spillway	5.5 feet (21-inch diameter standpipe)
Emergency Spillway	23 feet

Principal Spillway 838.0

Emergency Spillway 839.4

j. Regulating Outlets . . . . . None

SECTION 2: ENGINEERING DATA

2.1 Design

The Soil Conservation Service of Callaway County, Missouri has made available a set of surveying notes, two design drawings of the principal spillway and hydrologic and hydraulic computations. The drawings (dated May, 1973) show a profile along the centerline of the principal spillway and details of the drop inlet structure. The two design drawings are presented in this report as Plates 4 and 5 and the hydraulic calculations are shown on Plate 6.

According to the design drawings, the upstream slope was 1V to 3H and a 10-foot wide berm was located at 3 feet below the top of dam; however, field measurements resulted in an upstream slope of 1V to 2.5H and a berm, varying in width from 5 to 10 feet, located 3.25 feet below the top of dam. The design drawings also utilized an 18-inch inside diameter standpipe and a 12-inch inside diameter outlet pipe for the principal spillway; however, field measurements showed that a 21-inch inside diameter standpipe and a 10.5-inch inside diameter outlet pipe were used. It was also difficult to tell from the drawings whether two or three collars were constructed along the principal spillway outlet pipe.

2.2 Construction

No data are available concerning the construction of the dam and appurtenant structures.

2.3 Operation

No operation records are available for Hauck Lake Dam.

2.4 Evaluation

a. Availability

The availability of engineering data is poor and consists only of surveying notes, two design drawings of the principal spillway, hydrologic and hydraulic computations, a general soils map of the State of Missouri published by the Soil Conservation Service, State Geological Maps and U.S.G.S. quandrangle sheets. No information was available on construction or operation of the dam.

b. Adequacy

The available engineering data did not allow for a definitive review and evaluation. Therefore, the adequacy of this dam could not be assessed from the standpoint of reviewing and evaluating design, operation and construction data, but is based primarily on visual inspection, past performance history and present condition of the dam. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency. These seepage and stability analyses should be performed for appropriate loading conditions (including earthquake loads) and made a matter of record.

c. Validity

The only valid engineering data are the surveying notes, the two design drawings and the hydraulic computations obtained from the Soil Conservation Service. Only minor discrepancies between our field notes and the design drawings were noted and are described in Section 2.1. The hydraulic calculations show that the dam and

spillways were designed to pass at least the 50-year flood (two-percent chance flood). From our calculations (see Section 5.1d), it was determined that the dam and spillways are capable of passing the 100-year flood (one-percent chance flood) without overtopping the dam.

SECTION 3: VISUAL INSPECTION

3.1 Findings

a. General

A visual inspection of the Hauck Lake Dam was made on June 4, 1980. The following persons were present during the inspection:

Name	Affiliation	Disciplines
Mark Haynes, P.E.	PRC Engineering Consultants, Inc.	Project Engineer, Soils and Mechanical
Jerry Kenny	PRC Engineering Consultants, Inc.	Hydraulics and Hydrology
Robert McLaughlin, P.E.	PRC Engineering Consultants, Inc.	Civil
Razi Quraishi, R.P.G.	PRC Engineering Consultants, Inc.	Geology
Kevin Blume	Consoer, Townsend & Assoc., Ltd.	Civil and Structural

Specific observations are discussed below.

b. Dam

The overall condition of the dam appeared to be fair. However, some items of concern were observed and are described below.

The top of dam is adequately protected against surface erosion by an unmaintained vegetative cover. The top of dam is used occasionally as a farm road and consequently, tire tracks due to vehicular traffic were observed. No tire ruts or depressions which are sometimes associated with vehicular traffic across earthen structures were observed (see Photo 2). Some noncontinuous longitudinal and transverse cracks were measured up to 4 inches deep and 1/4 of an inch wide. No depressions indicating localized settlement of the dam were observed. No misalignment in either the vertical or horizontal directions was apparent. No evidence was observed indicating that the dam has ever been overtopped.

The upstream slope of the dam has no riprap protection and, consequently, a considerable amount of damage to the edge of the berm due to wave erosion has occurred. The erosion due to wave action has cut into the berm and has reduced its width to 5 feet in some areas. The berm and the slope above the berm are protected with an unmaintained grass cover (see Photo 1). In some areas, the grass cover was sparse and, consequently, some minor surface erosion has occurred. No large erosion gullies were observed. No depressions, bulges or cracks indicative of major slope or foundation movement were observed. Burrows approximately 1 inch in diameter were observed on the slope.

The downstream slope of the dam is covered by an unmaintained grass cover (see Photo 3). The grass cover was sparse in some areas and, consequently, minor surface erosion and some shallow surface scarps due to sloughing were noticed. A large area was observed downstream of the toe where no vegetative growth has occurred (see Photo 9). The area, according to Mr. Hauck, was a

coal spoil pile which was removed before the construction of the dam. The area is located just to the left of the service spillway outlet. The toe of the dam in this area is unprotected and, consequently, some erosion has occurred (see Photo 4). The scarp due to the erosion extends continuously along the toe in this area. Two areas of possible seepage were found near the toe of the slope. Boggy ground, standing water and cattails were observed in the two areas. One of the two areas was located approximately 100 feet to the left of the emergency spillway and the other approximately 218 feet to the right of the left abutment. No measurable seepage was observed. No bulges, depressions or cracks indicative of major slope or foundation movement were apparent. A comprehensive inspection of the entire embankment was hampered due to the unmaintained cover of grass.

Both abutments slope gently upward from the crest. No seepage, erosion or instabilities were observed on either abutment.

c. Project Geology and Soils

(1) Project Geology

The damsite is located on an unnamed tributary of Stinson Creek in the Dissected Till Plains Section of the central Lowland Physiographic Province. Loess-mantled Kansas drift covers the surface of most of the Dissected Till Plains Section. This section is distinguished from the Young Drift Section to the north and from the Till Plains on the east by the stage it has reached in the post-glacial erosion cycle. Broadly generalized, this section is a nearly flat till plain submature to mature in its erosion cycle.

The topography at the damsite is flat to rolling with V- to U-shaped valleys. Elevation ranges from 850 feet above M.S.L. at the damsite to 880 feet above M.S.L. nearly 1 mile southwest of the damsite. Stockpiles of coal waste from the strip mining operations are located approximately 0.75 miles northeast from the damsite.

The reservoir slopes are in the range of 5° from the horizontal at the western and northern sides, and between 10° and 16° from the horizontal at the southern side of the reservoir. The area near the damsite is covered with slope wash deposits of glacial-fluvial and loess origins consisting of mottled reddish brown to gray, silty clay.

The regional bedrock geology beneath the glacial outwash deposits in the damsite area, as shown on Geologic Map of Missouri (1979) (see Plate 7), consists of Pennsylvanian undifferentiated rocks and the Pennsylvanian Marmaton-Cherokee Group (cyclic deposits of shale, limestone, and sandstone), the Mississippian age Burlington Formation (cherty, grayish brown, sandy limestone), the Mississippian Chouteau Group, the Devonian Sulphur Springs Group (Bushberg Sandstone, Glen Park Limestone, Grassy Creek Shale), and Ordovician rocks consisting of Maquoketa Shale, Kimmswick Limestone, St. Peter Sandstone, Powell Dolomite and Roubidoux Formation.

The predominent bedrock near the damsite, underlying the glacial-fluvial deposits, are the Pennsylvanian undifferentiated rocks and cyclic deposits of shale, limestone and sandstone of the Marmaton Group. Inlet and outlet areas of the unnamed tributary of Stinson Creek exhibit quaternary alluvium.

No faults have been identified in the vicinity of the damsite. The closest trace of a fault to the damsite is the Kingdom City Fault nearly 4 miles northeast of the damsite. The Kingdom City Fault had its last movement in post-Ordovician time. Thus the fault has no effect on the damsite.

Hauck Lake Dam consists of a homogenous earthfill embankment, a drop inlet principal spillway with a metallic outlet pipe located near the mid-section of the embankment, and an emergency spillway located at the right abutment end of the embankment.

No boring logs or construction reports were available which would indicate foundation conditions encountered during the construction. Based on the visual inspection, the embankment probably rests on glacial-fluvial deposits (reddish brown, silty clay) and the principal spillway drop inlet and outlet pipe probably rest on compacted embankment. The emergency spillway was cut into the compacted embankment fill (mottled grayish red, silty clay).

(2) Project Soils

According to the "Missouri General Soil Map and Soil Association Description" published by the Soil Conservation Service, the materials in the general area of the dam belong to the soil series of Weller - Keswick - Lindley - Mandeville in the Central Mississippi Valley Wooded Slopes forest. The soils are basically formed from loess, glacial till and weathered shale. The permeability of these soils ranges from slow to moderate. The Lindley soil is generally quite susceptibleto erosion. If the Lindley soil type was used in the embankment, the potential of failure of the embankment would be increased due to erosion during overtopping.

Materials removed from the upstream and downstream slopes of the embankment appeared to be a light brown, mottled yellow, red and gray, silty clay with some fine to medium sand. Based upon the Unified Soil Classification System, the soil would probably be classified as a CL. This is an impervious soil type, which generally has the following characteristics: a coefficient of permeability less than 1.0 foot per year, medium shear strength, and a high resistance to piping.

d. Appurtenant Structures

(1) Principal Spillway

The principal spillway is a drop inlet type spillway. On the day of the inspection, there was no flow over the crest; in fact, the water level was almost a foot below the crest. However, water was observed dripping from the outlet end of the pipe. A metal patch was welded to the inside of the standpipe, as if to repair a possibly corroded area; the standpipe and the anti-vortex device are not protected against rust and corrosion. The inside of this spillway was not accessible for inspection; however, from the design sheet it can be seen that the standpipe is welded to a flat metal base plate, 3.5-feet square and 3/8 of an inch thick. Also, the conduit protrudes through and into the riser pipe, as noted from the field inspection. The outlet end of the spillway pipe emerges from the embankment at the toe of the dam with about 15 feet of the conduit exposed. This section of the pipe has a black protective coating, albeit in shreds (possibly worn off from the weather), and the last 10 feet of the pipe have an anomalous curvature as though inherent in the structure of the pipe (see Photo 7). Some apparent corrosion was observed on the inside of the principal spillway standpipe, and rust covered the anti-vortex device and what could be seen of the standpipe (see Photo 6).

(2) Emergency Spillway

The emergency spillway crest is bare in spots and is generally sparsely covered with a protective growth of grass; some surface erosion has occurred and the inlet area is somewhat obstructed with a growth of reeds (see Photo 8). The remainder of the discharge channel is well protected with a tall growth of grass as is the highway drainage channel with a concrete lining. There is a fairly good sized rodent hole (see Photo 5) in the left berm area near the top of dam. Driftwood, etc. has gathered in an area of the reservoir which is very close to the emergency spillway inlet.

(3) Outlet Works

There were no regulated outlet works or low level drain pipes constructed for this dam.

e. Reservoir Area

The reservoir water surface elevation at the time of inspection was 837.2 feet above M.S.L.

The surface area of the reservoir at normal water level is about 15 acres. The rim appears to be stable with no severe erosional problems. The land around the reservoir slopes gently to the rim and is grass and/or tree covered. There are no homes built in close proximity to the reservoir (see Photo 12).

f. Downstream Channel

The downstream channel is not well defined and partially obstructed from the embankment to the County Highway F embankment which is located approximately 200 feet downstream of the dam (see Photos 9 and 10). Discharges through the spillways of the dam pass under the highway through the 4-foot high, 5-foot wide concrete box culvert (see Photo 11).

7.2 Evaluation

The visual inspection uncovered nothing of a consequential nature which would require immediate remedial action. However, some conditions were observed which could adversely affect the dam in the near future.

1. The possible seepage, indicated by the cattails, standing water and boggy ground at the downstream toe, could affect the structural stability of the dam. If the rate of seepage were to increase, it is possible that the seepage could transport soil particles which could

cause piping of embankment material thus leading to an eventual failure of the embankment.

2. The wave erosion on the upstream slope does not appear to affect the stability of the dam in its present condition. Nevertheless, continual erosion of the slope can only be detrimental to the stability of the dam.

3. It is unknown whether the cracks observed on the crest are indicative of shrinkage, slope movement, or foundation settlement. Due to their extent and location, the cracks were probably caused by shrinkage.

4. The rodent activity observed on the upstream slope and on the emergency spillway training berm near the embankment could jeopardize the safety of the dam. However, the large rodent burrow found on the edge of the emergency spillway could cause problems, the severity of which would depend upon the extent, activity, and direction of the burrowing. The burrows created by the animals make avenues for possible piping.

5. The surface erosion, due to the lack of protective cover in some areas of the slopes and the area to the left of the principal spillway outlet at the toe of the slope, does not appear to affect the stability of the dam in its present condition.

6. The present vegetation on the embankment should be properly maintained. A tall growth of vegetation on the embankment hinders a comprehensive inspection of the dam and potential problems could go undetected.

7. Some apparent corrosion was observed on the inside of the stand pipe of the principal spillway, and rust covered the anti-vortex device and what could be seen of the standpipe (see Photo 6). It would seem likely that the portion of the conduit within the embankment has a protective coating of the same material that was observed on the outlet

end of the pipe. However, since there was a small amount of water dripping from the outlet end, water is apparently entering the pipe through faulty seams, corroded areas, or through some other way. If from corrosion, the condition could eventually worsen to the point of allowing embankment material to be washed into the pipe.

8. In a large flood, the driftwood would drift to the inlet of the emergency spillway, possibly getting snagged in the reeds and simulating a trashrack, and contribute to the problem of rising reservoir water.

9. The discharge channel of the emergency spillway generally does not appear to be adequately protected against erosion due to flows through the spillway which could threaten the safety of the dam.

SECTION 4: OPERATIONAL PROCEDURES

4.1 Procedures

Hauck Lake Dam was built to impound water primarily for recreational purposes. There are no specific procedures which are followed for the operation of the dam.

4.2 Maintenance of Dam

The dam and appurtenant structures are maintained by the owner, Mr. Gordon K. Hauck. The dam is covered with a dense blanket of grass. The slopes are free of trees and bushes. Erosion is present at the toe of the dam near the spoil pile as explained in Section 3.1b. Some surface erosion is also present in the emergency spillway channel. The berm on the upstream slope has undergone considerable erosion due to wave action.

4.3 Maintenance of Operating Facilities

There are no operable facilities at the damsite which require any maintenance.

4.4 Description of Any Warning System in Effect

The inspection team is not aware of any warning system consisting of any electrical warning system or manual notification plans in use at the damsite.

4.5 Evaluation

Although the maintenance of Hauck Lake Dam seems to be somewhat lacking, the dam does not appear to be neglected. The remedial measures described in Section 7 should be undertaken to improve the condition of the dam.

SECTION 5: HYDRAULIC/HYDROLOGIC

5.1 Evaluation of Features

a. Design Data

The watershed area of the Hauck Lake Dam upstream from the dam axis is approximately 95 acres. The watershed area consists mainly of pasture and range land. Land gradients in the watershed average roughly 3 percent. The Hauck Lake Dam Reservoir is located on an unnamed tributary of Stinson Creek. The reservoir is about 0.6 miles upstream from the confluence of the unnamed tributary and Stinson Creek. At its longest arm the watershed is approximately 0.4 miles long. A drainage map showing the watershed and the downstream hazard zone is presented as Plate 1 in Appendix B.

Evaluation of the hydraulic and hydrologic features of Hauck Lake Dam was based on criteria set forth in the Corps of Engineers' "Engineer Regulation No. 1110-2-106" and additional guidance provided by the St. Louis District of the Corps of Engineers. The Probable Maximum Flood (PMF) was calculated from the Probable Maximum Precipitation (PMP) using the methods outlined in the U.S. Weather Bureau Publication, Hydrometeorological Report No. 33. The probable maximum storm duration was set at 24 hours, and storm rainfall distribution was based on criteria given in the Corps of Engineers' EM 1110-2-1411 (Standard Project Storm). The Soil Conservation Service (SCS) method was used for deriving the unit hydrograph, utilizing the Corps of Engineers' computer program HEC-1 (Dam Safety Version). The unit hydrograph parameters are presented in Appendix B. The SCS method was also used for determining the loss rate. The hydrologic soil group of the watershed was determined by use of the published soil maps. The hydrologic soil group of the watershed and the SCS curve number are presented in Appendix B. The curve number, the unit hydrograph parameters, the PMP index

rainfall and the percentages for various durations were direct input to the HEC-1 (Dam Safety Version) computer program to obtain the PMF hydrograph. The computed peak discharges of the PMF and the one-half PMF are 2,332 cfs and 1,166 cfs, respectively.

Both the PMF and the one-half PMF inflow hydrographs were routed through the reservoir by the Modified Puls Method also utilizing the HEC-1 (Dam Safety Version) computer program. A storm of 50 percent of the PMF preceded the PMF and a storm of 25 percent of the PMF preceded the one-half PMF, each by 4 days. The starting elevation for routing antecedent floods was assumed to be equal to the mean annual high water level in the reservoir. The mean annual high water level for Hauck Lake Dam Reservoir was estimated to be at the crest of the principal spillway. The water level in the reservoir at the end of the four day routing period was at the same elevation, within 0.1 feet, as the crest of the principal spillway. The reservoir was assumed at this level at the start of the routing computations for the PMF and the one-half PMF. The peak outflow discharges for the PMF and the one-half PMF are 1,526 and 296 cfs, respectively. Only the PMF when routed through the reservoir resulted in overtopping of the dam. Downstream of Hauck Lake Dam, Hignway F was studied to demonstrate that the highway embankment will not be overtopped during a PMF event even in the case of the dam being overtopped, and the backwater created by the roadway culvert will not affect the discharge rating curve.

The sizes of physical features utilized to develop the stage-outflow relation for the spillway and overtopping of the dam were taken from field notes and sketches, prepared during the field inspection. The reservoir stage-capacity data were based on the U.S.G.S. Fulton, Missouri Quadrangle topographic map (7.5 minute series). The reservoir elevation-area curve and the spillway and dam overtop rating curve are presented in Plates 2 and 3, respectively, in Appendix B.

From the standpoint of dam safety, the hydrologic design of a dam must aim at avoiding overtopping. Overtopping is especially dangerous for an earth dam because of its erosive characteristics. The safe hydrologic design of an embankment dam requires a spillway discharge capability combined with an embankment height that can handle a very large and exceedingly rare flood without dam overtopping.

The Corps of Engineers designs dams to safely pass the Probable Maximum Flood that could be generated from the dam's watershed. This is the generally accepted criterion for major dams throughout the world, and is the standard for dam safety where overtopping of the dam would pose any threat to human life. Accordingly, the hydrologic requirement for safety for this dam is the capability to pass the Probable Maximum Flood without overtopping the dam.

b. Experience Data

It is believed that records of reservoir stage or spillway discharge are not maintained for this site. Nevertheless, there was no evidence of the dam ever being overtopped.

c. Visual Observations

Observations made of the spillways during the visual inspection are discussed in Section 3.1d and evaluated in Section 3.2.

d. Overtopping Potential

As indicated in Section 5.1.a, the Probable Maximum Flood when routed through the reservoir, resulted in overtopping of the dam. The peak outflow discharges for the PMF and the one-half PMF are 1,526 and 296 cfs, respectively. The capacity of the spillway just before overtopping is approximately 418 cfs. The PMF over-

topped the dam by 0.65 feet. The total duration of flow over the dam is 1 hour during the PMF. The spillway/reservoir system of Hauck Lake Dam is capable of accommodating a flood equal to approximately 60 percent of the PMF just before overtopping of the dam. The reservoir/spillway system of Hauck Lake Dam will accommodate the one-percent chance flood (100-year flood) without exceeding the top of dam.

The estimated damage zone extends approximately four miles downstream of the dam. There are six dwellings, one building, a junkyard, a shed, a school, and a park within the damage zone. Due to the particular location of the dam behind the embankment of Highway F, the downstream hazard zone could be considered safe in the event of the PMF. However, this depends upon the strength of the highway embankment since highway embankments are not designed to impound water and if the box culvert under the highway embankment is not plugged, over which Mr. Hauck has no control.

SECTION 6: STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability

a. Visual Observations

There were no major signs of settlement or distress observed on the embankment or foundation during the visual inspection. The possible seepage observed in the two different locations at the toe of dam could be detrimental to the stability of the embankment. Nevertheless, the possible seepage did not appear to constitute an unsafe condition at this time. It was not apparent whether the observed cracks on the top of dam were due to shrinkage, slope movement, or foundation settlement. Due to the extent and location of the cracks, the cracks were probably caused by shrinkage. The erosional problems due to wave action on the upstream berm, and due to surface runoff on the upstream slope, downstream slope, and the toe of dam to the left of the principal spillway pipe, do not endanger the structural integrity of the embankment in their present condition. Nevertheless, if the erosion continues, it can only have an adverse effect on the stability of the embankment. In the absence of seepage and stability analyses, no quantitative evaluation of the structural stability can be made.

The spillway system appeared to be structurally stable on the day of the inspection. The pipe curvature at the outlet end was seen as a defective piece of pipe, not necessarily causing any instability. It is assumed that the pipe within the embankment is not defective in this manner.

b. Design and Construction Data

Hydrologic and hydraulic analyses for this project were available and are presented in this report (see Plate 6). From the hydrologic and hydraulic computations, it appears that the dam and appurtenant structures were designed to pass a two-percent chance flood. No design computations pertaining to the embankment were uncovered during the report preparation phase. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available. No embankment or foundation soil parameters were available for carrying out a conventional stability analysis on the embankment. No construction data or specifications relating to the degree of embankment compaction were available for use in a stability analysis.

c. Operating Records

No operating records are available relating to the stability of the dam or appurtenant structures. The water level on the day of inspection was 10 inches below the crest of the principal spillway, and it is assumed that the reservoir remains close to full at all times. No regulated outlet works or low level outlets were provided for this dam.

d. Post Construction Changes

No post construction changes to the embankment are known to exist which will affect the structural stability of the dam.

e. Seismic Stability

The dam is located in Seismic Zone 1 (see Plate 9), as defined in "Recommended Guidelines for Safety Inspection of Dams" prepared by the Corps of Engineers, and will not require a seismic stability analysis. An earthquake of the magnitude which would be expected in Seismic Zone 1 will not cause significant distress to a

well designed and constructed earth dam. Available literature indicates that no active faults exist near the vicinity of the damsite.

SECTION 7: ASSESSMENT/REMEDIAL MEASURES

7.1 Dam Assessment

The assessment of the general condition of the dam is based upon available data and the visual inspection. Detailed investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation, however, the investigation is intended to identify any need for such studies.

It should be realized that the reported condition of the dam is based on observations of field conditions at the time of the inspection along with data available to the inspection team.

It is also important to realize that the condition of a dam depends upon numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be assurance that an unsafe condition would be detected.

a. Safety

The spillway capacity of Hauck Lake Dam is found to be "Inadequate". The spillway/reservoir system will accommodate about 60 percent of the PMF without overtopping the dam. The safety of the embankment will be in jeopardy if the dam is overtopped. The dam itself would be susceptible to erosion due to the high velocity of flow on its downstream slope which could lead to an eventual failure of the dam.

The dam and appurtenant structures appeared to be in fair condition. However, no quantitative evaluation of the safety of the embankment can be made in view of the absence of seepage and stability analyses. The present embankment and appurtenant structures, however, appear to have performed satisfactorily since their construction without failure or evidence of instability. There was no evidence of the dam ever having been overtopped.

The safety of the dam can be improved if the deficiencies described in Sections 3 and 6.1a are properly corrected as described in Section 7.2b.

b. Adequacy of Information

The conclusions presented in this report are primarily based upon field measurements and present condition of the dam. The two design drawings and the hydrologic and hydraulic computations were of limited use to the overall assessment of the dam and appurtenant structures. Information on the operation and maintenance of the dam was not available. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency.

c. Urgency

The remedial measures recommended in Paragraph 7.2 should be accomplished in the near future. The items recommended in Paragraph 7.2a should be pursued on a high priority basis.

d. Necessity for Phase II Inspection

Based upon results of the Phase I inspection, and assuming the remedial measures recommended in Paragraph 7.2 are undertaken, a Phase II inspection is not felt to be necessary.

7.2 Remedial Measures

a. Alternatives

There are several general options which may be considered to reduce the possibility of dam failure or to diminish the harmful aspects of such a failure. Some of these options are:

1. Increase the spillway capacity to pass the PMF without overtopping the dam.

2. Increase the height of the dam enough to pass the PMF without overtopping the dam; an investigation should be done which also includes studying the effects on the structural stability of the existing embankment. The overtopping depth during the occurrence of the PMF, stated in Section 5.1d, is not the required or recommended increase in the height of the dam.

3. A combination of 1 and 2 above.

b. O & M Procedures

1. The possible seepage at the downstream toe should be monitored to detect any changes in turbidity, location or quantity. Any changes should be investigated further by a qualified engineer and repairs made as necessary.

2. The erosion due to wave action on the upstream berm should be properly repaired and protected from further damage.

3. The observed cracking on the top of dam should be monitored to ensure that it is not symptomatic of distress in the slopes or foundation. Large cracks should be properly repaired

4. Determine the extent of damage done to the embankment by burrowing animals, if any, and make corrective repairs as required. All burrowing animals should be eliminated from the embankment and their burrows properly backfilled and compacted.

5. The areas on the embankment, where the vegetation is sparse and erosion due to surface runoff has occurred, should be properly repaired and then adequately protected from surface erosion by a good vegetative cover.

6. The vegetation on the embankment should be maintained periodically and large vegetation, such as bushes and trees, should be prevented from growing on the slope.

7. The driftwood, etc. in the reservoir, especially in the vicinity of the emergency spillway inlet, should be removed from the reservoir and the discharge channel of the emergency spillway (especially near the crest of the spillway) should be adequately protected to prevent excessive erosion due to flows through the spillway.

8. The functioning of the principal spillway system should be monitored in order to determine the severity and progression of the leaks, if any, in the conduit system.

9. Seepage and stability analyses should be performed by a professional engineer experienced in the design and construction of earth dams.

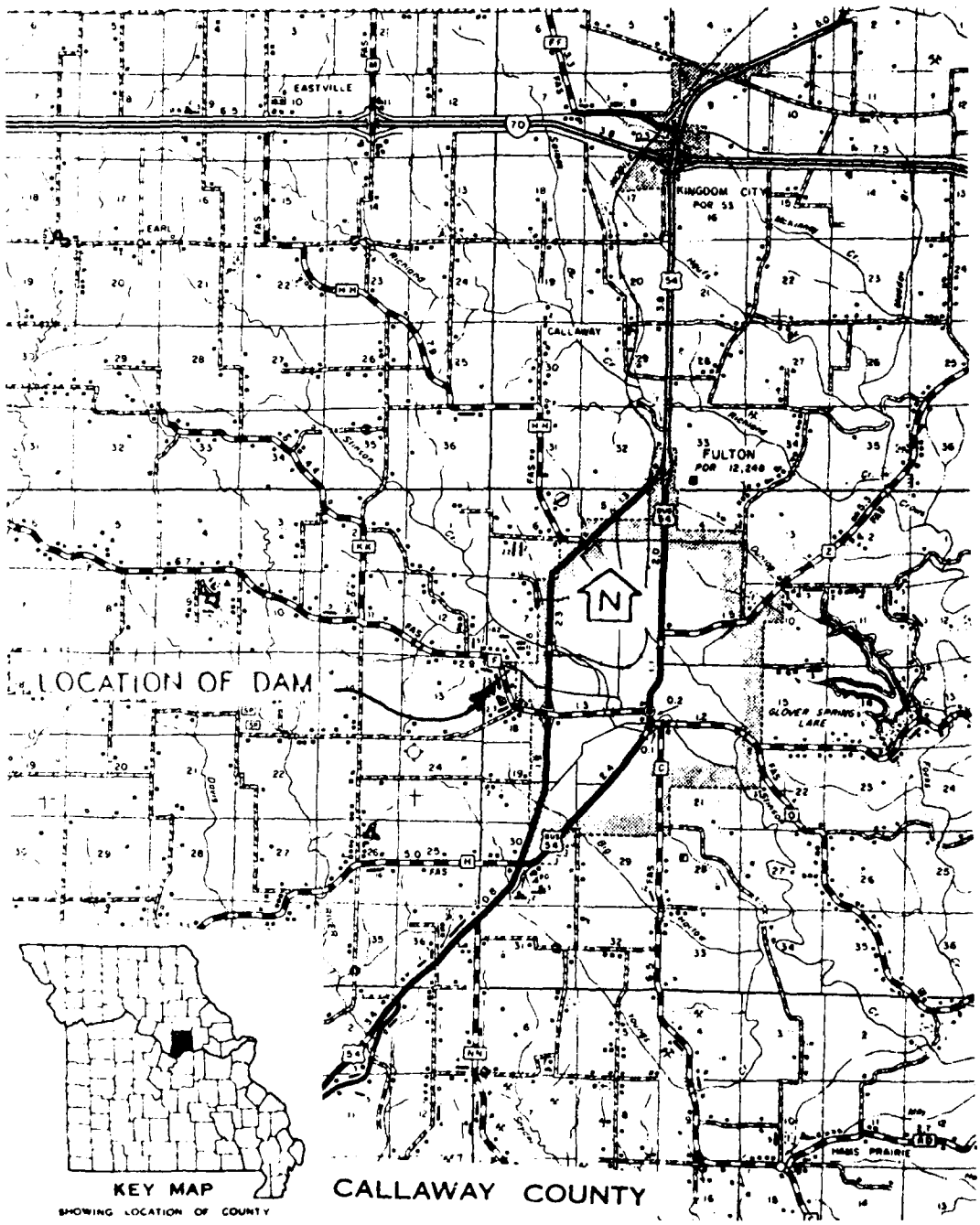
10. The owner should initiate the following programs:

    (a) Periodic inspection of the dam by a professional engineer experienced in the design and construction of earth dams.

(b) Set up a maintenance schedule and log all visits to the dam for operation, repairs and maintenance.

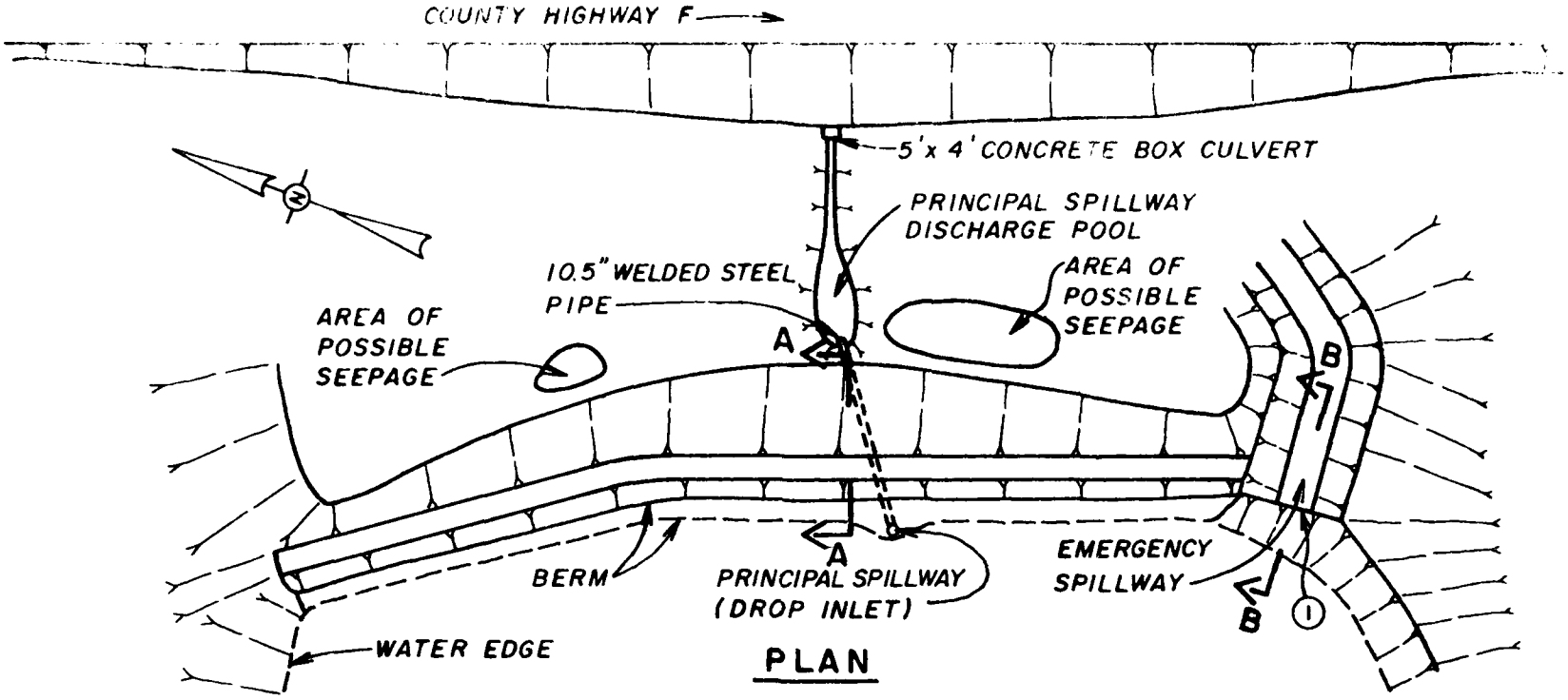
PLATES

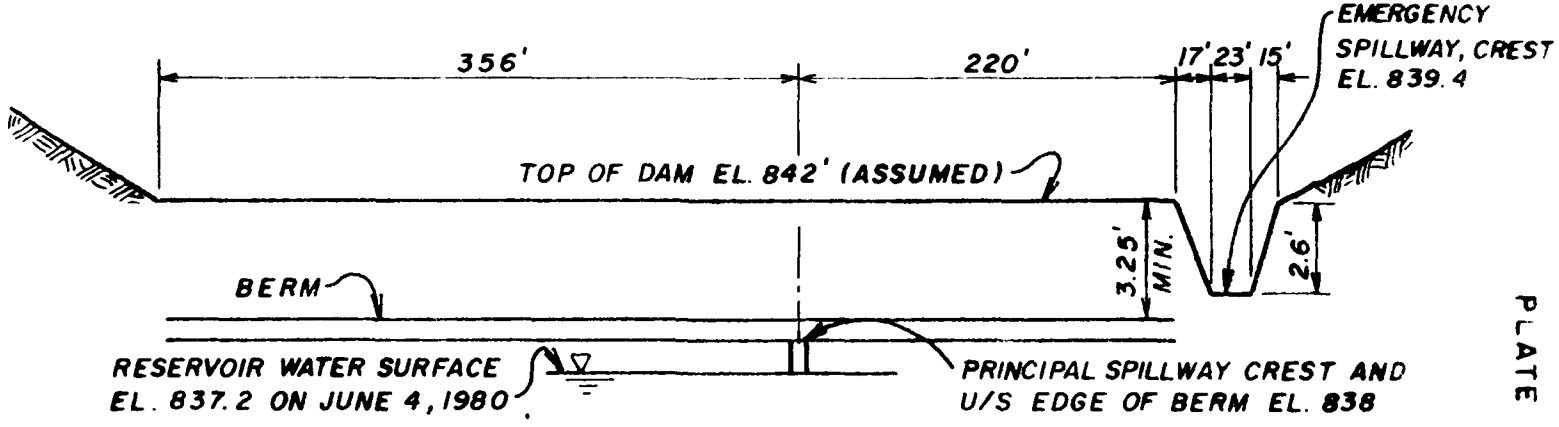
PLATE 1



LOCATION MAP – HAUCK LAKE DAM

MO 10989



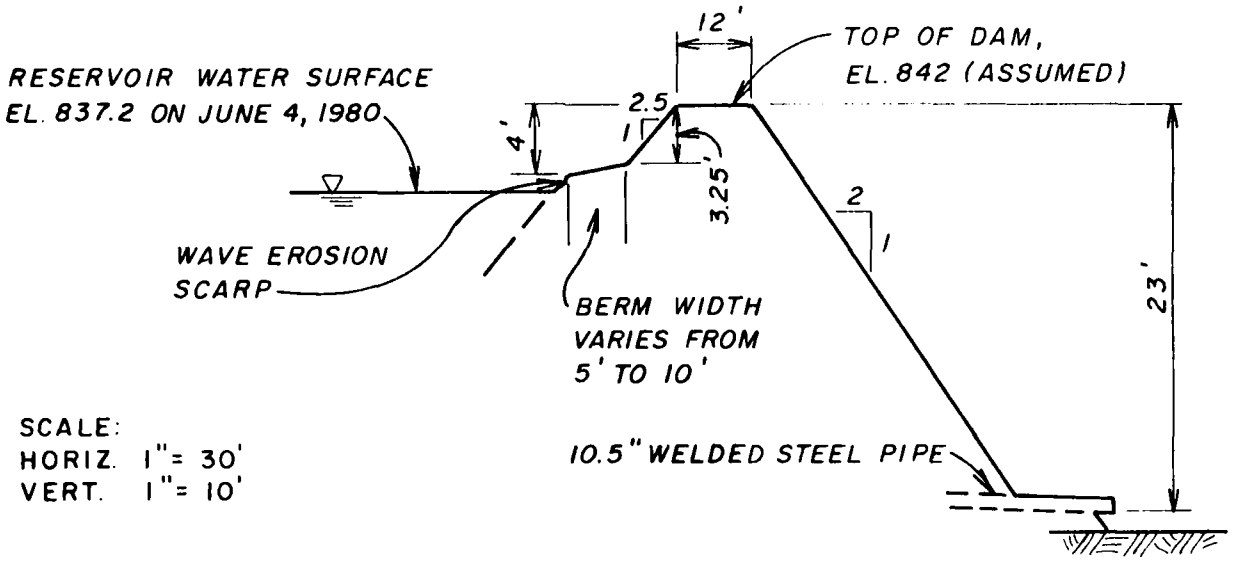


SCALE:
HORIZ. 1"= 100'
VERT. 1"= 5'

HAUCK LAKE DAM (MO. 10969)
PLAN AND ELEVATION
(SHEET 1 OF 2)

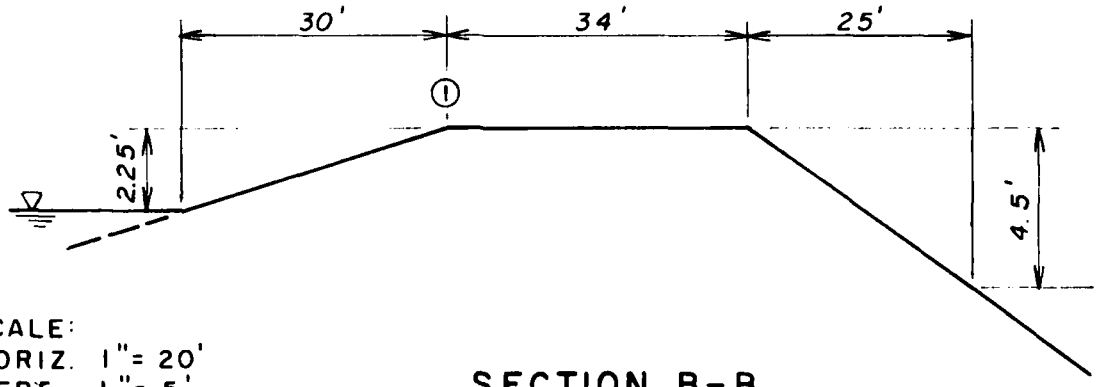
PLATE 2

PLATE 3



SCALE:
HORIZ. 1" = 30'
VERT. 1" = 10'

SECTION A-A
MAXIMUM SECTION

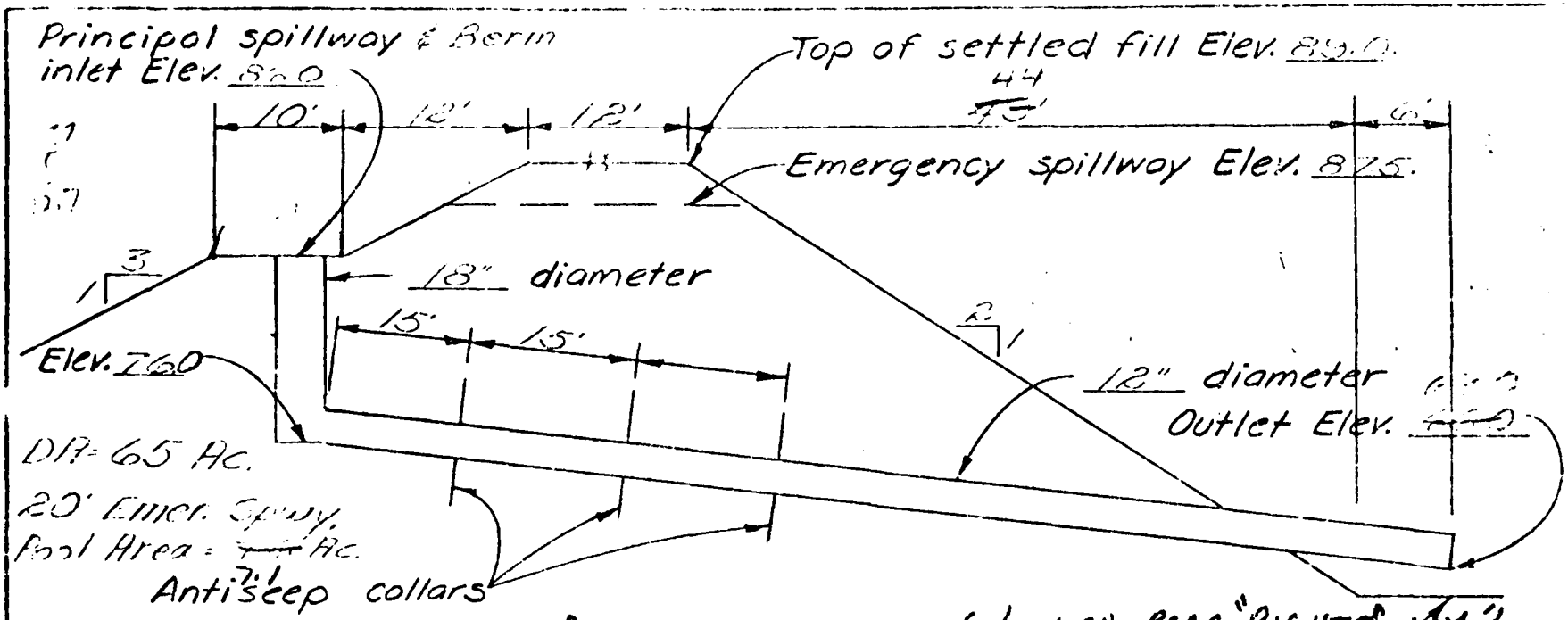


SCALE:
HORIZ. 1" = 20'
VERT. 1" = 5'

SECTION B-B
EMERGENCY SPILLWAY PROFILE

① *REFERENCE POINT SHEET 1 OF 2*

HAUCK LAKE DAM (MO. 10989)
MAXIMUM SECTION OF EMBANKMENT AND
EMERGENCY SPILLWAY PROFILE
(SHEET 2 OF 2)



SECTION ALONG ℄ PRINCIPAL SPILLWAY
Not to Scale

ESTIMATED QUANTITIES

QUAN	UNIT	ITEM
~~70~~ 81	ft.	10" ~~12~~" W.S.P.
10	ft.	18" W.S.P.
1	ea.	3'-6" X 12" Anti-Vortex
1	ea.	3'-6" X 3'-6" Riser Base Plate 3/8"
4	ft.	2" X 2" X 1/4" Angle Iron
2	ea.	5' X 5' Anti-Seep Collars
~~[illegible]~~ 35	C.Y.	Earthfill
~~[illegible]~~ 362	C.Y.	

COOPERATOR Gordon Houck SEC. [illegible] T. [illegible] R. [illegible]
COOPERATING WITH
COUNTY Calloway STATE Mo.
SURVEYED L.R. 1-28 DATE 4-73

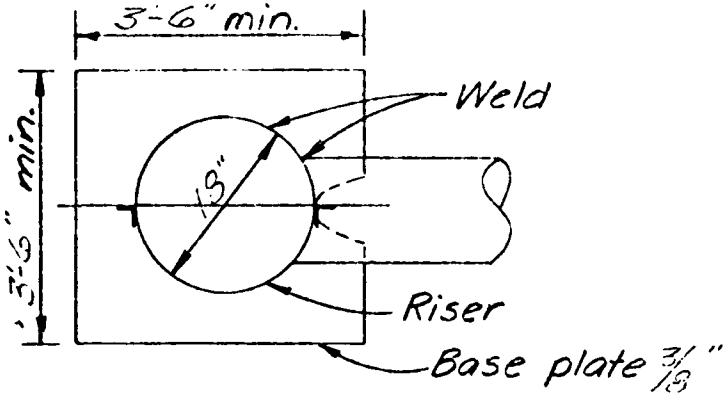
DROP INLET SPILLWAY

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

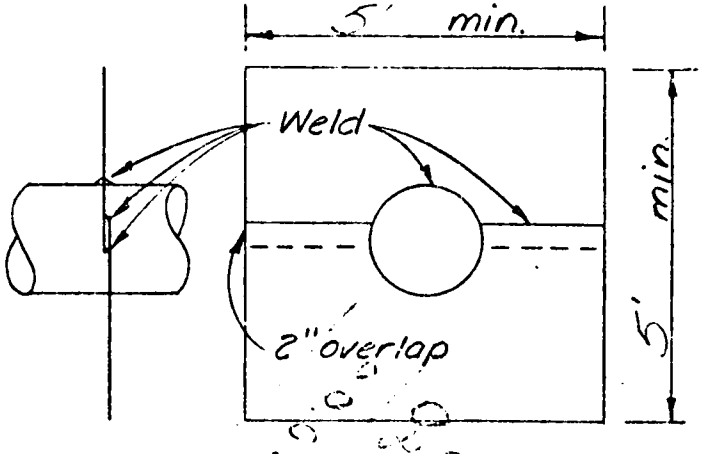
Designed CB	Date 9/72	Approved by [illegible]	
Drawn CB	3/73	Title [illegible]	
Traced		Title	
Checked [illegible]		Sheet No. 1 of 2	Drawing No. 10-73

PLATE 4

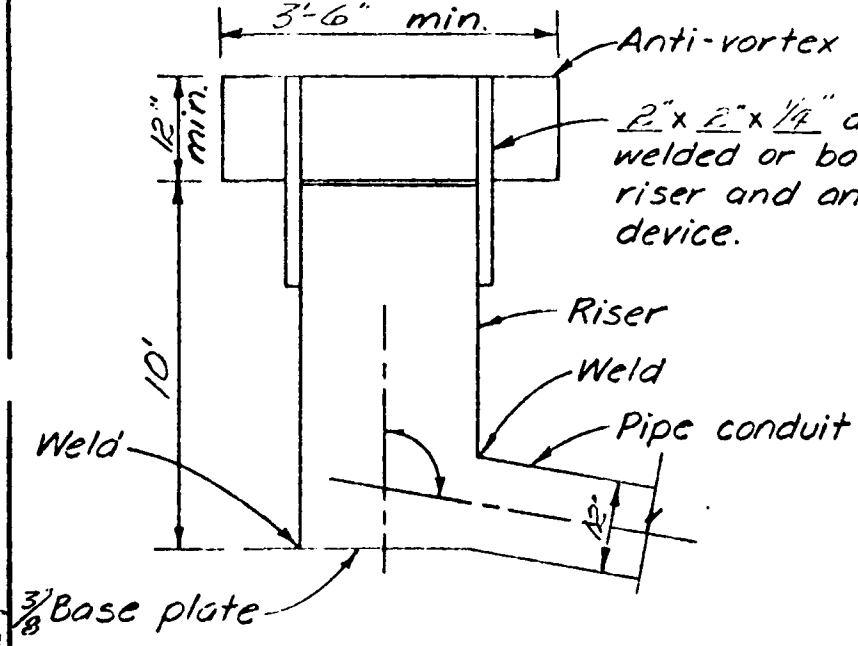
SCS-ENG-50 2/70 File Code ENG-13 USDA SCS LINCOLN, NEBR. 1970 S.L.-27,950



TOP VIEW



ANTI-SEEP COLLAR



SECTION ALONG ℄ OF INLET

INLET SECTION

Not to Scale

Notes:

1. All welds shall be watertight except angle iron connections
2. All pipe and steel plates shall have minimum thickness of 0.179"

COOPERATOR G. Hauck SEC. T. R.

COOPERATING WITH

COUNTY STATE

SURVEYED DATE

DETAILS FOR WELDED STEEL PIPE DROP INLET SPILLWAY

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Designed Date Approved by

Drawn Title

Traced Title

Checked Sheet No. 2 of 2 Drawing No. 10-73

PLATE 5

CALCULATION SHEET

SCS-ENG-5-58

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

BY	DATE	CHECKED BY	DATE	JOB NO.
SUBJECT				SHEET OF

A.S.= .65 Acres

Q= .77 x 2.60 x I x V x S x C x P = cfs Mul

Q= .77 cfs Vr.= .65 x .462 = 1.8 Ac. Ft.

Q= 1.40 cfs Vr.= .65 x 2.62 = 1.70 Ac. Ft.

8.6

10" VSP L= 80' D= 20' Q= 1.3 cfs Outlet El. 6.2

Capacity = .263 Vs= 193 x 1.7 = 13.7 Ac. Ft.

EMERGENCY SPILLWAY d= 0.5' W= 7' S= 1.0'

Vs. Vr= pool Qsp= Q= .03 x 240 x 7 cfs

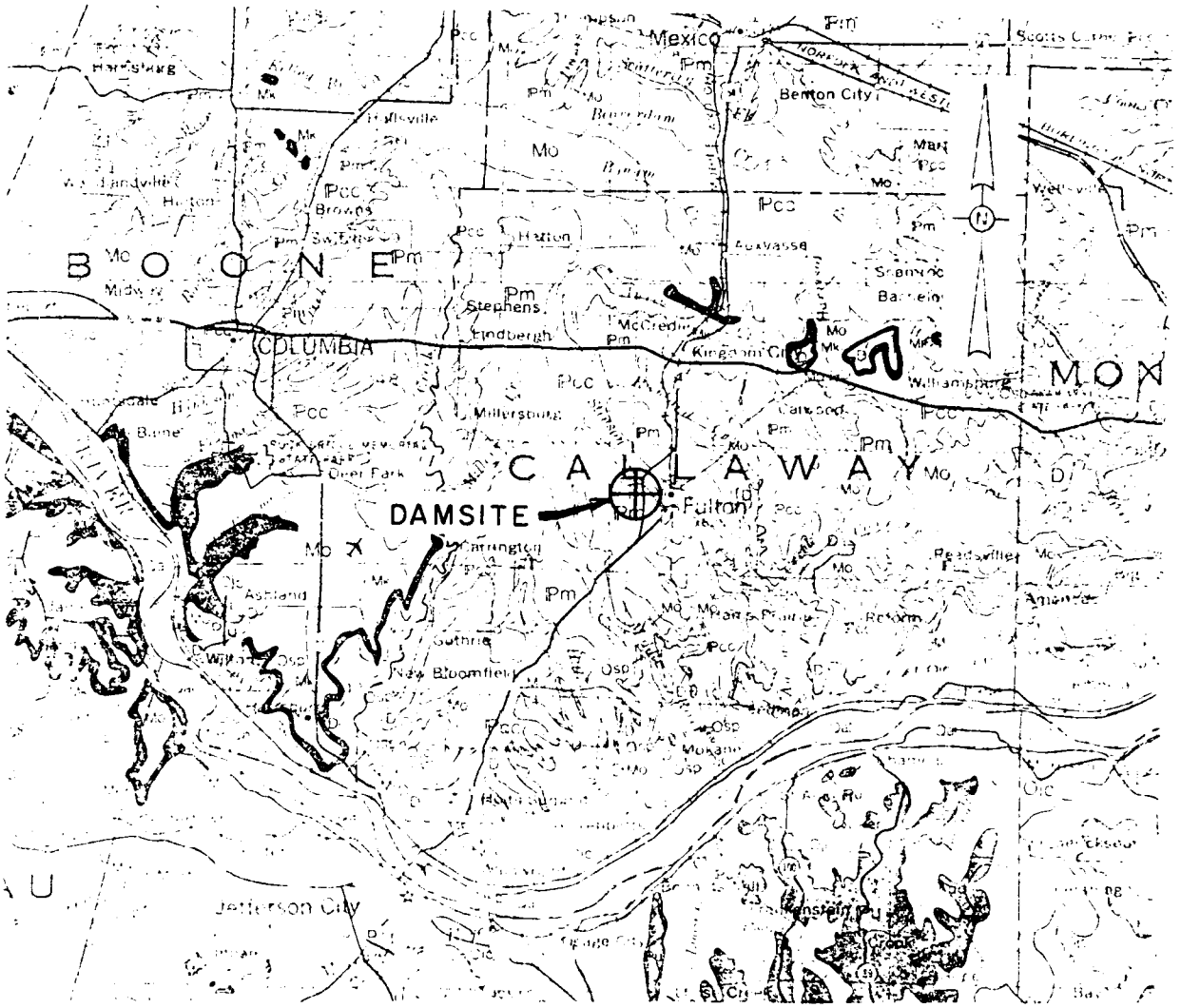
[illegible] Storage

18.0 / 17 / 94

CB 9-20-74

dam relocation

PLATE 7



SCALE

0 10 20 30 40 Miles

⊕ LOCATION OF DAM

NOTE: LEGEND OF THIS DAM IS ON PLATE 8

REFERENCE

GEOLOGIC MAP OF MISSOURI
DEPARTMENT OF NATURAL RESOURCES
MISSOURI GEOLOGICAL SURVEY
KENNETH H. ANDERSON, 1979

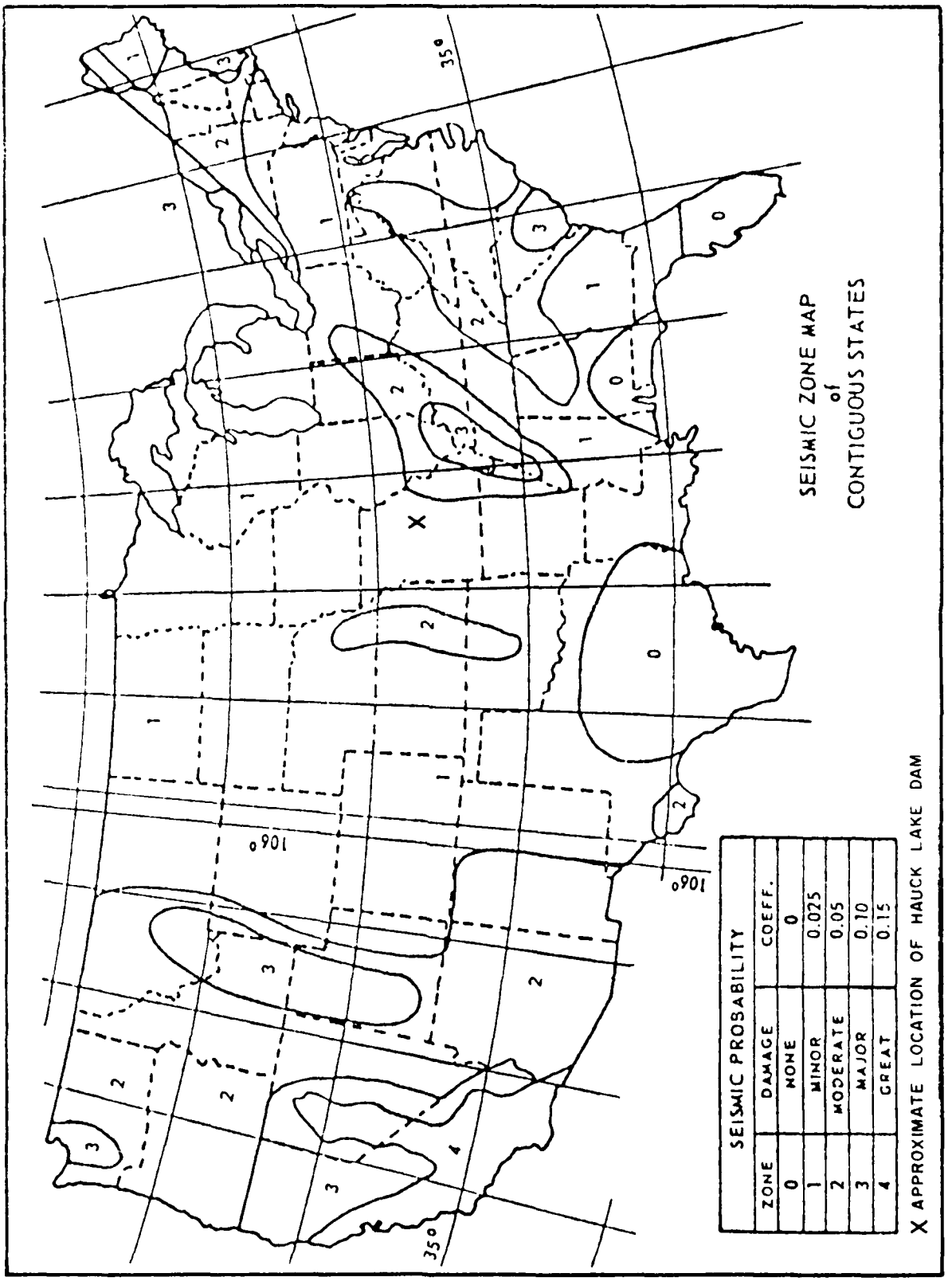
REGIONAL GEOLOGICAL MAP
OF
HAUCK LAKE DAM

HAUCK LAKE DAM
PLATE 8

LEGEND

PERIOD	SYMBOL	DESCRIPTION
QUATERNARY	Qal	ALLUVIUM: SAND, SILT, GRAVEL
PENNSYLVANIAN	Pu	PENNSYLVANIAN UNDIFFERENTIATED
	Pm	MARMATON GROUP: CYCLIC DEPOSITS OF SHALE, LIMESTONE AND SANDSTONE
	Pcc	CHEROKEE GROUP: CYCLIC DEPOSITS OF SHALE, LIMESTONE AND SANDSTONE
MISSISSIPPIAN	Mo	KEOKUK- BURLINGTON FORMATION: CHERTY GRAYISH BROWN SANDY LIMESTONE
	Mk	CHOUTEAU GROUP: NORTHVIEW, COMPTON AND BACHELOR FORMATION (LIMESTONE AND SHALE
DEVONIAN	D	SULPHUR SPRING GROUP: BUSHBERG SANDSTONE, GLEN PARK LIMESTONE, GRASSY CREEK SHALE
ORDOVICIAN	Ou	MAQUOKETA SHALE, KIMMSWICK LIMESTONE
	Osp	ST PETER SANDSTONE
	Ojc	SMITHVILLE FORMATION, POWELL DOLOMITE
	Or	ROUBIDOUX FORMATION: LIMESTONE AND SANDSTONE

PLATE 9


SEISMIC ZONE MAP
of
CONTIGUOUS STATES
SEISMIC PROBABILITY
ZONE | DAMAGE | COEFF.
0 | NONE | 0
1 | MINOR | 0.025
2 | MODERATE | 0.05
3 | MAJOR | 0.10
4 | GREAT | 0.15
X APPROXIMATE LOCATION OF HAUCK LAKE DAM
35°
106°
106°
35°

APPENDIX A

PHOTOGRAPHS TAKEN DURING INSPECTION

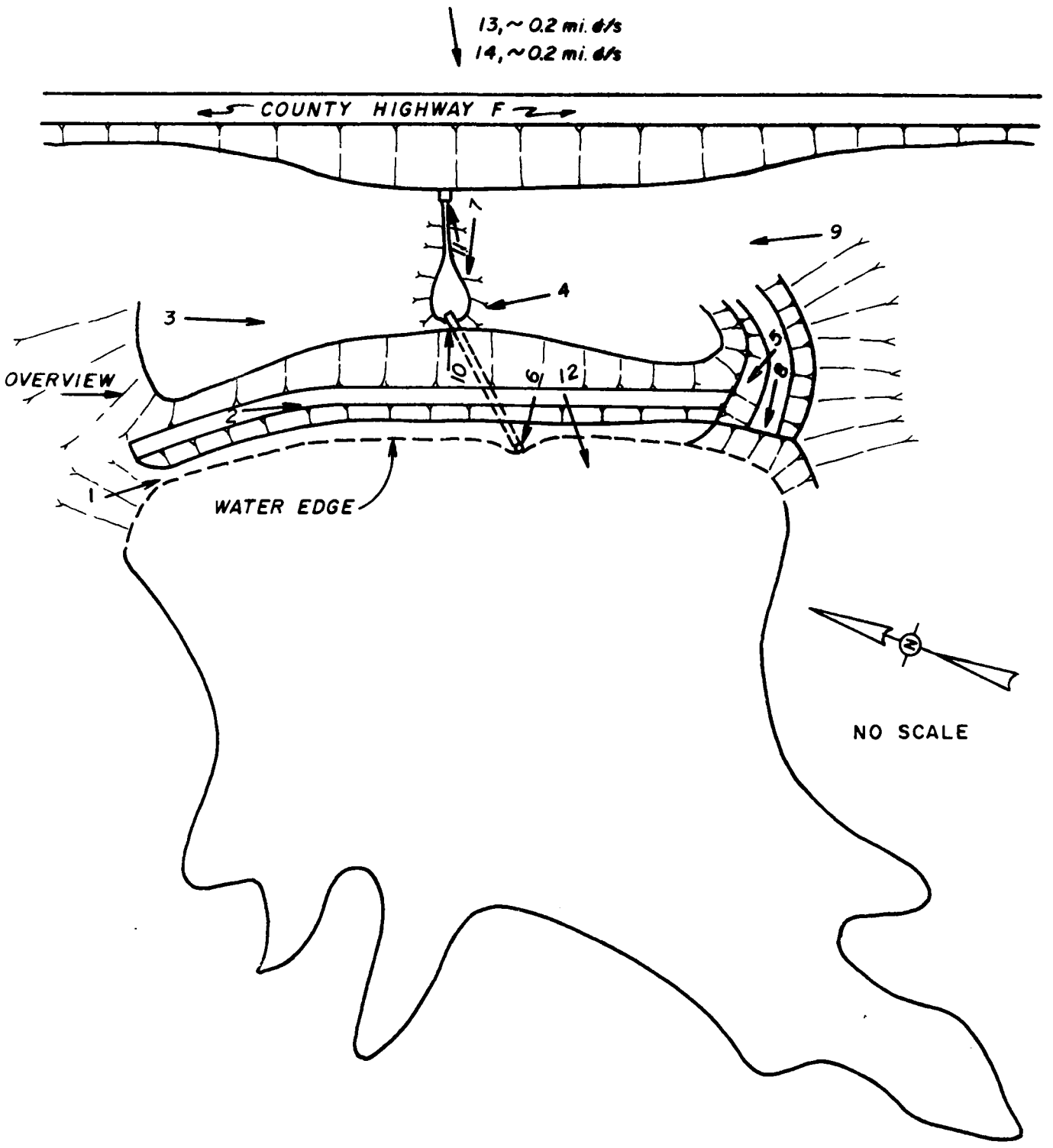


PHOTO INDEX
FOR
HAUCK LAKE DAM

Hauck Lake Dam

Photographs

Photo 1 - View of the upstream slope showing uneven berm and tall grass slope protection.

Photo 2 - View of the top of dam showing tall stand of grass.

Photo 3 - View of the downstream slope showing tall grasses, toe of slope, and emergency spillway discharge channel berm.

Photo 4 - View of the principal spillway outlet and discharge pool showing large bare area and scarp along the toe.

Photo 5 - Burrow found on the berm on the left side of the emergency spillway near the dam embankment.

Photo 6 - View of the principal spillway showing anti-vortex device, rust condition, reeds around inlet, and low water level.

Photo 7 - View of the principal spillway outlet showing discharge pool, end pipe curvature, and lack of grass cover protection.

Photo 8 - Crest of emergency spillway looking towards reservoir showing sparseness of grass cover, and reeds at inlet area.

Photo 9 - Photo shows the dam embankment on left, highway embankment on right, bare spot in center, and emergency spillway discharge channel in foreground.

Photo 10 - Principal spillway outlet showing discharge pool, erosion flow, downstream channel and concrete box culvert under highway.

Photo 11 - Close-up view of reinforced concrete box culvert (5 feet wide by 4 feet high) under highway embankment adjacent dam embankment.

Photo 12 - View of the reservoir and rim.

Photo 13 - View of the downstream hazard located approximately 0.2 miles downstream of the dam.

Photo 14 - View of the downstream hazard located approximately 0.2 miles downstream of the dam.

Photo 1

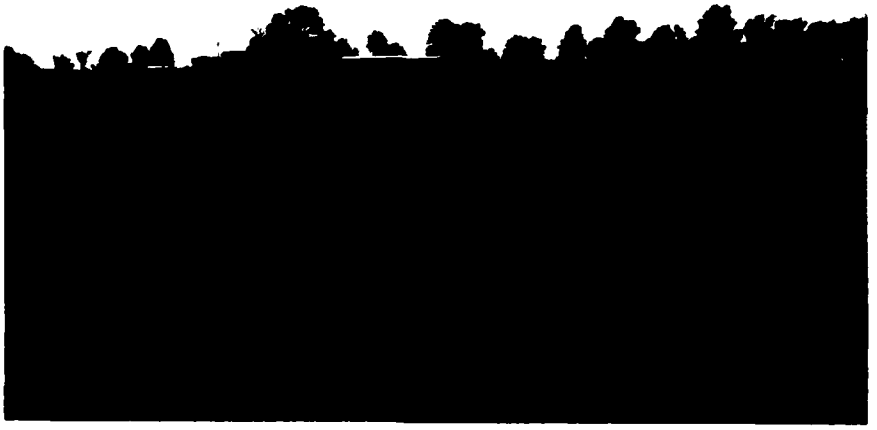


Photo 2

Photo 3

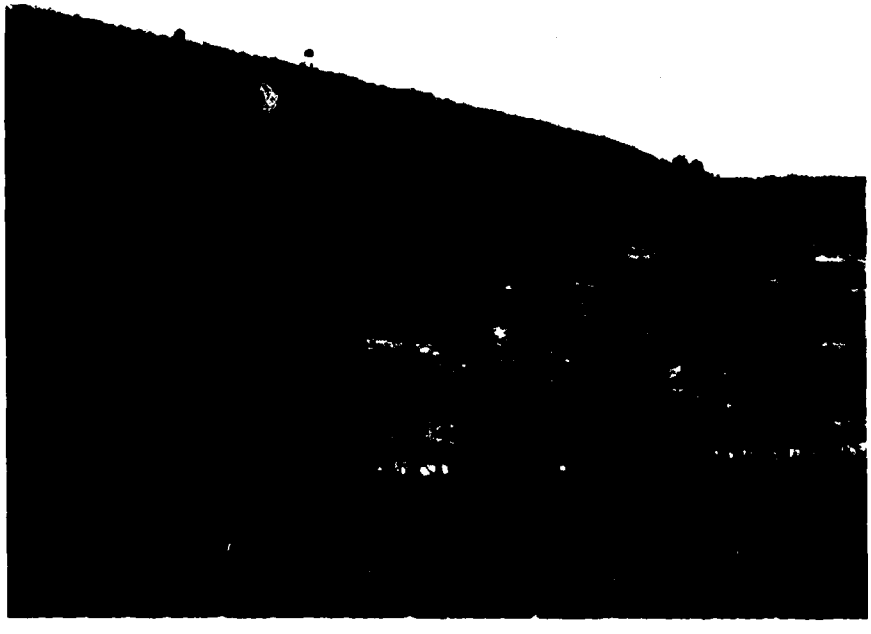


Photo 4

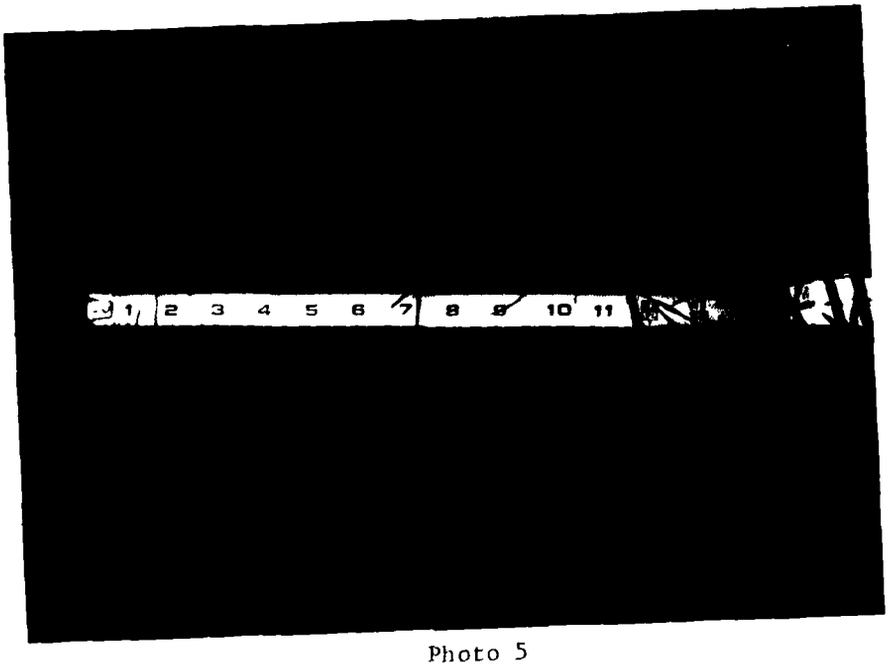


Photo 5

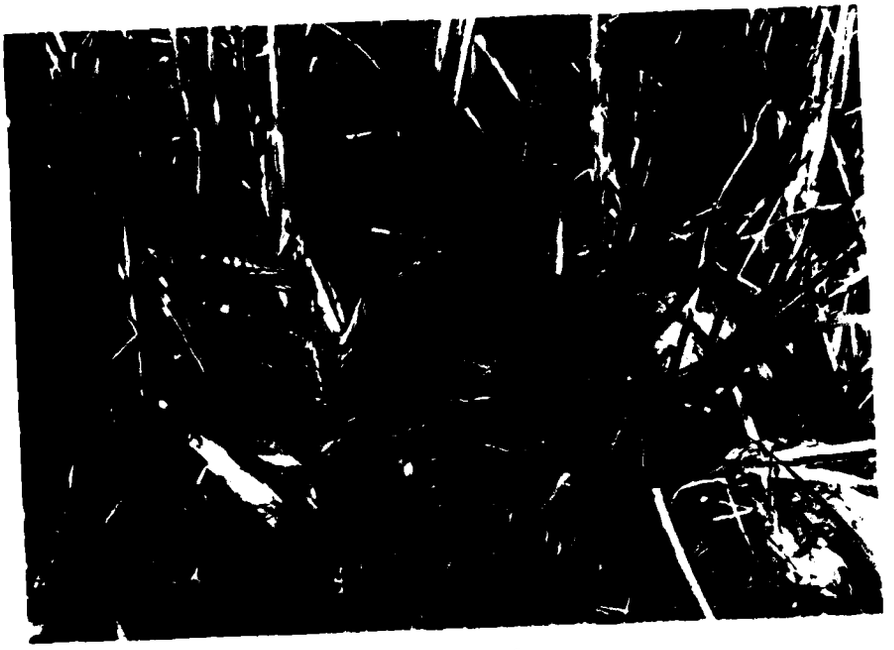


Photo 6

Photo 7

Photo 8

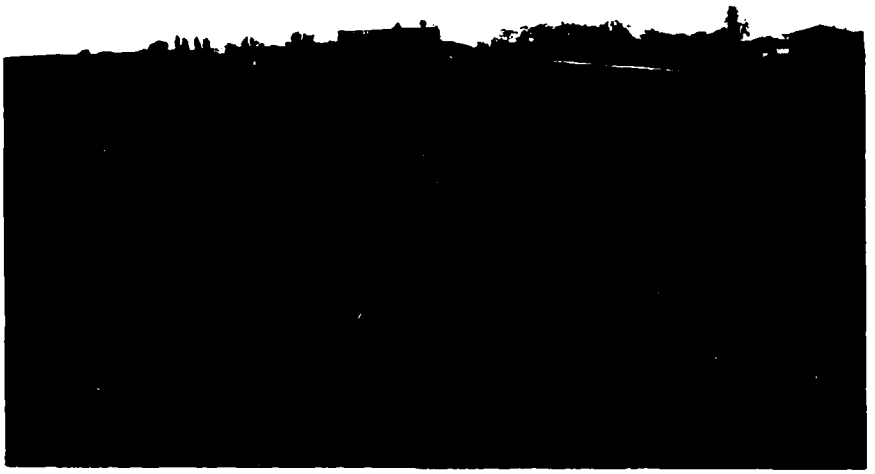


Photo 9

Photo 10

Hauck Lake Dam

Photo 11

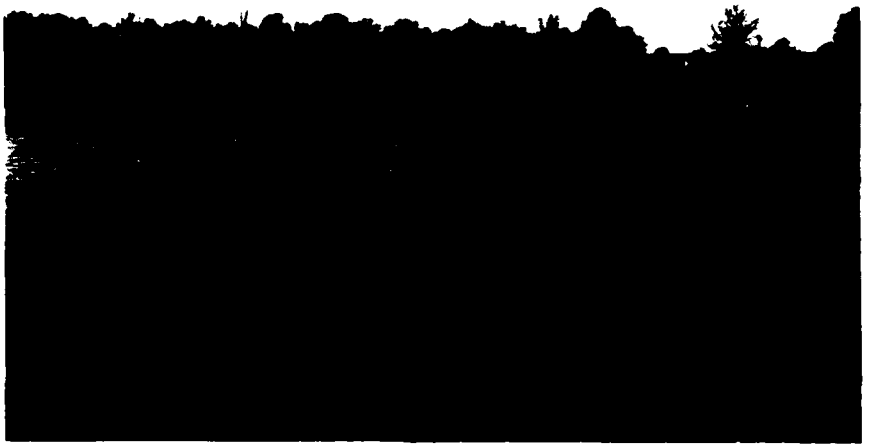


Photo 12

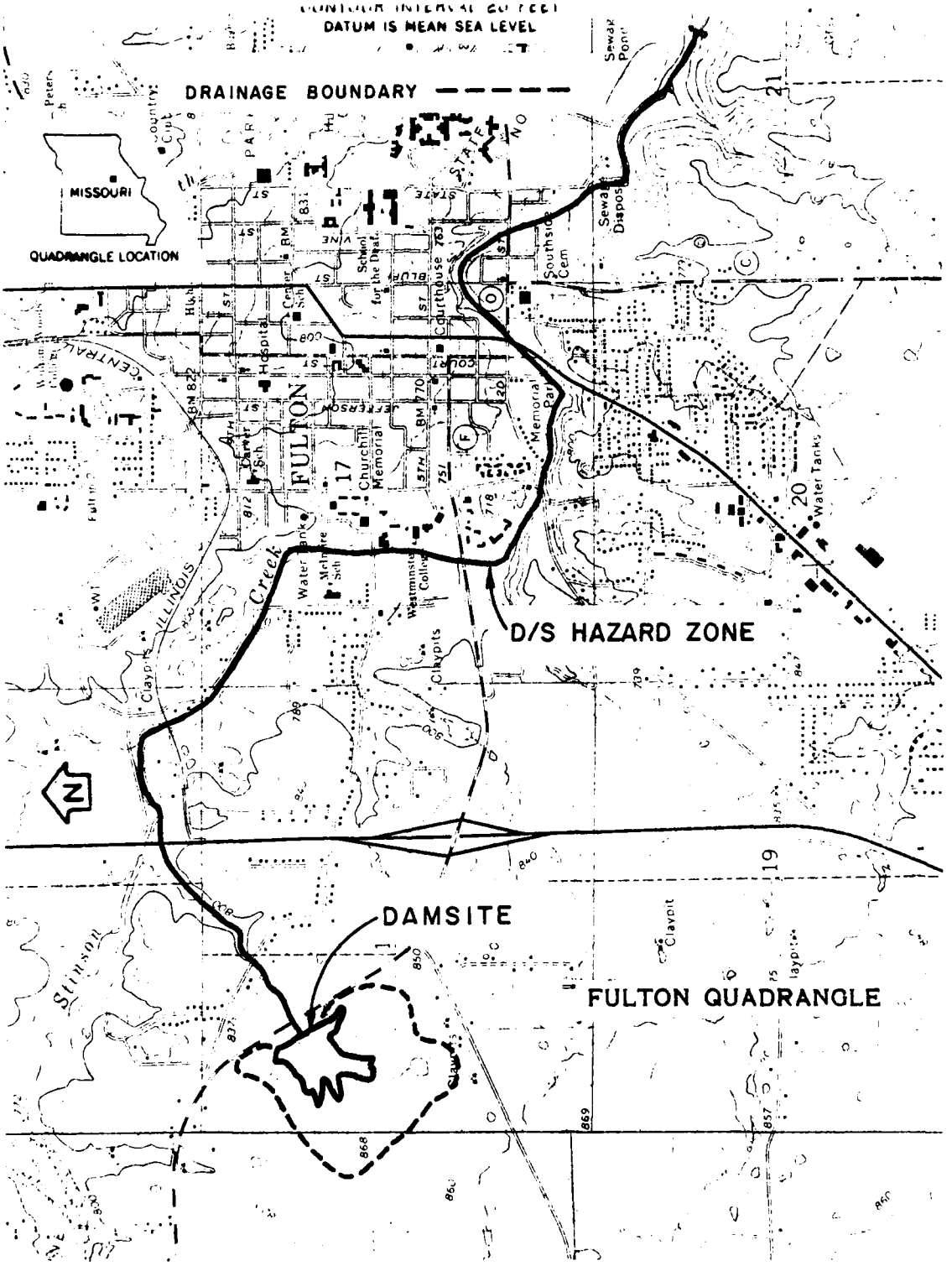
Photo 13

Photo 14

APPENDIX B

HYDROLOGIC AND HYDRAULIC COMPUTATIONS

PLATE I, APPENDIX B



HAUCK LAKE DAM (MO. 10989)
DRAINAGE BASIN AND
DOWNSTREAM HAZARD ZONE

ECI-4 **PRC ENGINEERING CONSULTANTS, INC.**

DAM SAFETY INSPECTION - MISSOURI SHEET NO. ____ OF ____

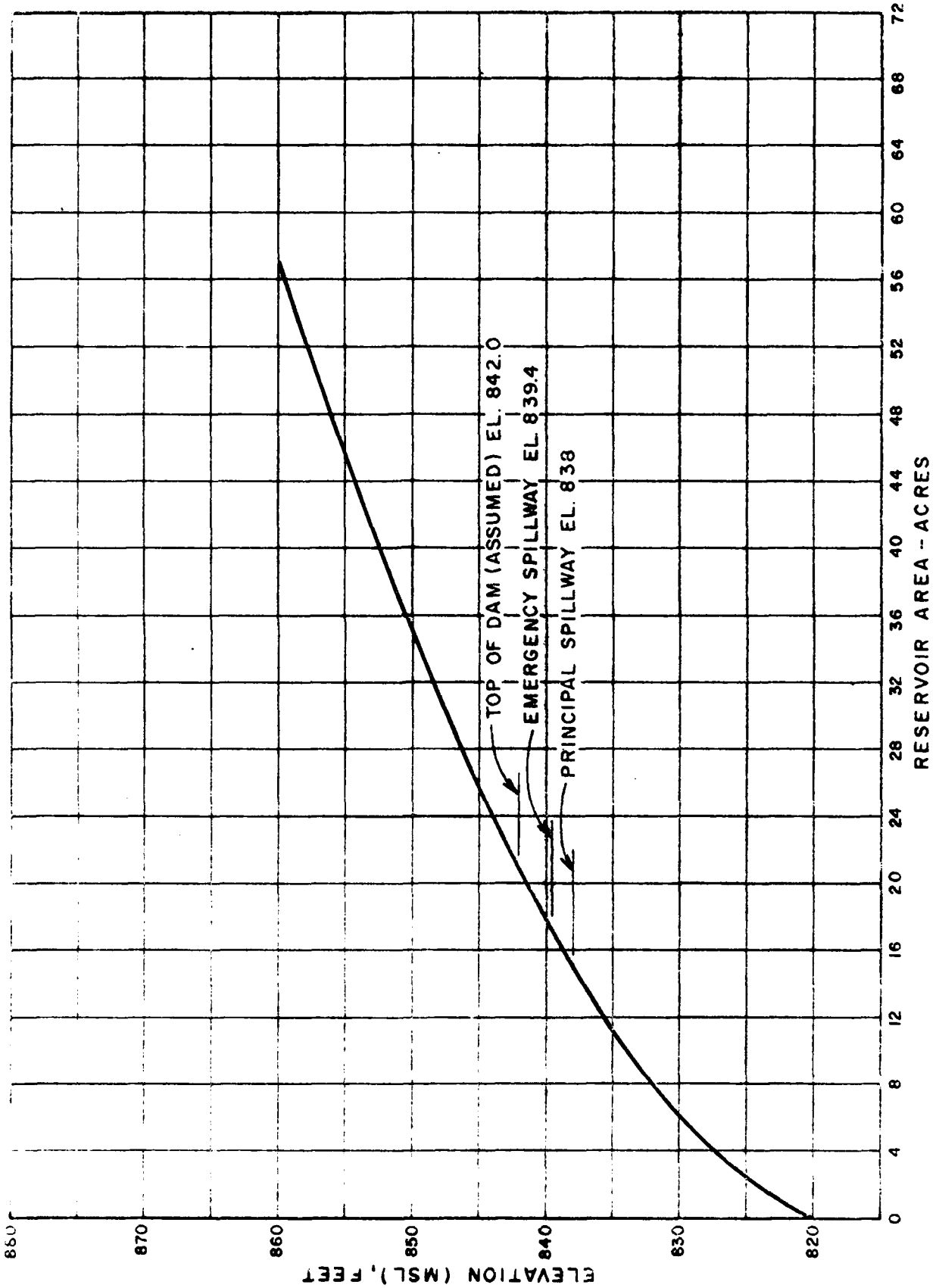
DAM NAME: HAUCK LAKE DAM / ID NO.: 10989 JOB NO. 1263

RESERVOIR ELEVATION - AREA DATA BY FZ DATE JUNE 80

KLB ✓

ELEV. (M.S.L.) (Ft.)	RESERVOIR SURFACE AREA (Acres)	REMARKS
820	0	Assumed bottom.
823	1	Measured on USGS Quad.
830	6	Interpolated.
838	15	" , Principal Spillway
839.4	17	" , Emergency Spillway.
840	18	Measured on USGS Quad
842	21	Interpolated , Top of dam (Assumed)
850	35	"
860	57	Measured on USGS Quad.

PLATE 2, APPENDIX B



HAUCK LAKE DAM (MO. 10989)
RESERVOIR ELEVATION-AREA CURVE

ECI-4 **PRC ENGINEERING CONSULTANTS, INC.**

DAM SAFETY INSPECTION / MISSOURI — SHEET NO. ___ OF ___

DAM NAME: HAUCK LAKE DAM — JOB NO. 1263

UNIT HYDROGRAPH PARAMETERS — BY FZ DATE JUNE 80

KLB

1) DRAINAGE AREA, $A = 0.148$ sq. mi = (95 acres)

2) LENGTH OF STREAM, L = (0.5 " × 2000 ' = 1000 ') = 0.189 mi.

3) ELEVATION AT DRAINAGE DIVIDE ALONG THE LONGEST STREAM,

$H_1 = 865$

4) ELEVATION OF RESERVOIR AT SPILLWAY CREST, $H_2 = 838$

5) ELEVATION OF CHANNEL BED AT 0.85L, $E_{85} = 863$

6) ELEVATION OF CHANNEL BED AT 0.10L, $E_{10} = 840$

7) AVERAGE SLOPE OF THE CHANNEL, $S_{AVG} = (E_{85} - E_{10})/0.75L = 0.03$

8) TIME OF CONCENTRATION:

A) BY KIRPICH'S EQUATION,

$$t_c = [(11.9 \times L^3)/(H_1 - H_2)]^{0.385} = \left(\frac{11.9 \times 0.189^3}{865 - 838}\right)^{0.385} = 0.11$$

B) BY VELOCITY ESTIMATE,

SLOPE = 3% ⟹ AVG. VELOCITY = 3 fps

$$t_c = L/V = \frac{1000}{3} \times \frac{1}{3600} = 0.09 \text{ hr}$$

USE $t_c = 0.11$

9) LAG TIME, $t_l = 0.6\, t_c = 0.064$

10) UNIT DURATION, $D \leq t_l/3 = 0.021$ < 0.083 hr.

USE $D = 0.083$

11) TIME TO PEAK, $T_p = D/2 + t_l = 0.106$

12) PEAK DISCHARGE,

$$q_p = (484 \times A)/T_p = \frac{484 \times 0.148}{0.106} = 680 \text{ cfs}$$

ECI-4 **PRC ENGINEERING CONSULTANTS, INC.**

DAM SAFETY INSPECTION / MISSOURI - 1980 SHEET NO. ____ OF ____

DAM NAME: HAUCK LAKE DAM JOB NO. 1263

CURVE NUMBER DETERMINATION BY FZ DATE JUNE 80

KLD

I) SOIL GROUP

WATERSHED SOILS IN THE BASIN CONSIST OF GROUP A. B. C. D.

WELLER, KESWICK, LINDLEY, MANDEVILLE

GROUP C SOILS SEEM TO PREDOMINATE THE BASIN. THEREFORE, ASSUME GROUP C SOILS FOR THE ENTIRE WATERSHED FOR HYDROLOGIC PURPOSES.

II) COVER COMPLEX

ASSUMED LAND USE	ASSUMED HYDROLOGIC CONDITION	PER CENT AREA	CN (AMC II)
RANGE	FAIR	100	79

III) CURVE NUMBER

WEIGHTED AVERAGE CN = 79 FOR AMC II

CURVE NUMBER = 91 FOR AMC III

ECI-4 **PRC ENGINEERING CONSULTANTS, INC.**

DAM SAFETY INSPECTION / MISSOURI SHEET NO. ____ OF ____

DAM NAME: HAUCK LAKE DAM JOB NO. 1263

PROBABLE MAXIMUM PRECIPITATION BY FZ DATE JUNE 80

KLB

DETERMINATION OF PMP

1) Determine drainage area of the basin

D.A. = 45 Ac = 0.15 Sqmi

2) Determine PMP Index Rainfall (for D.A. = 200 sq. mi & 24 hr. duration)

Location of centroid of basin,

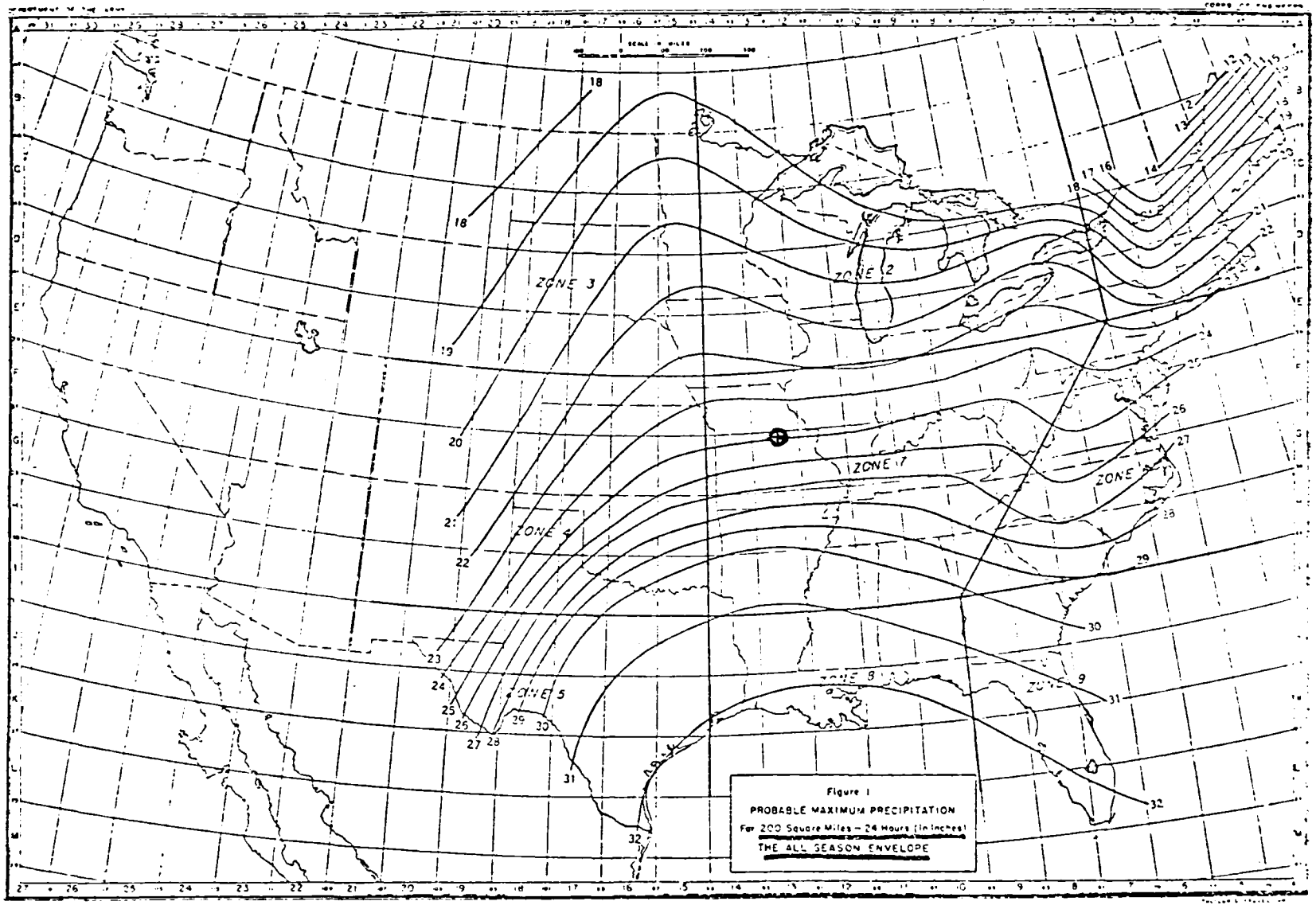
Long. = 91° 58' 52" Lat. = 38° 51' 05"

PMP = 24.9" (from Fig. 1, HMR 33)

Zone = 7

3) Determine basin rainfall in terms of percentage of PMP Index Rainfall for various durations. (from Fig. 2, HMR 33)

Duration (Hrs.)	Percent of Index Rainfall (%)	Total Rainfall (Inches)	Rainfall Increments (Inches)	Duration of Increment (Hrs.)
6	100	24.9	24.9	6
12	120	29.9	5	6
24	130	32.4	2.5	12



⊕ Location of Basin Centroid

Hauck Lake Dam (MO. 10983

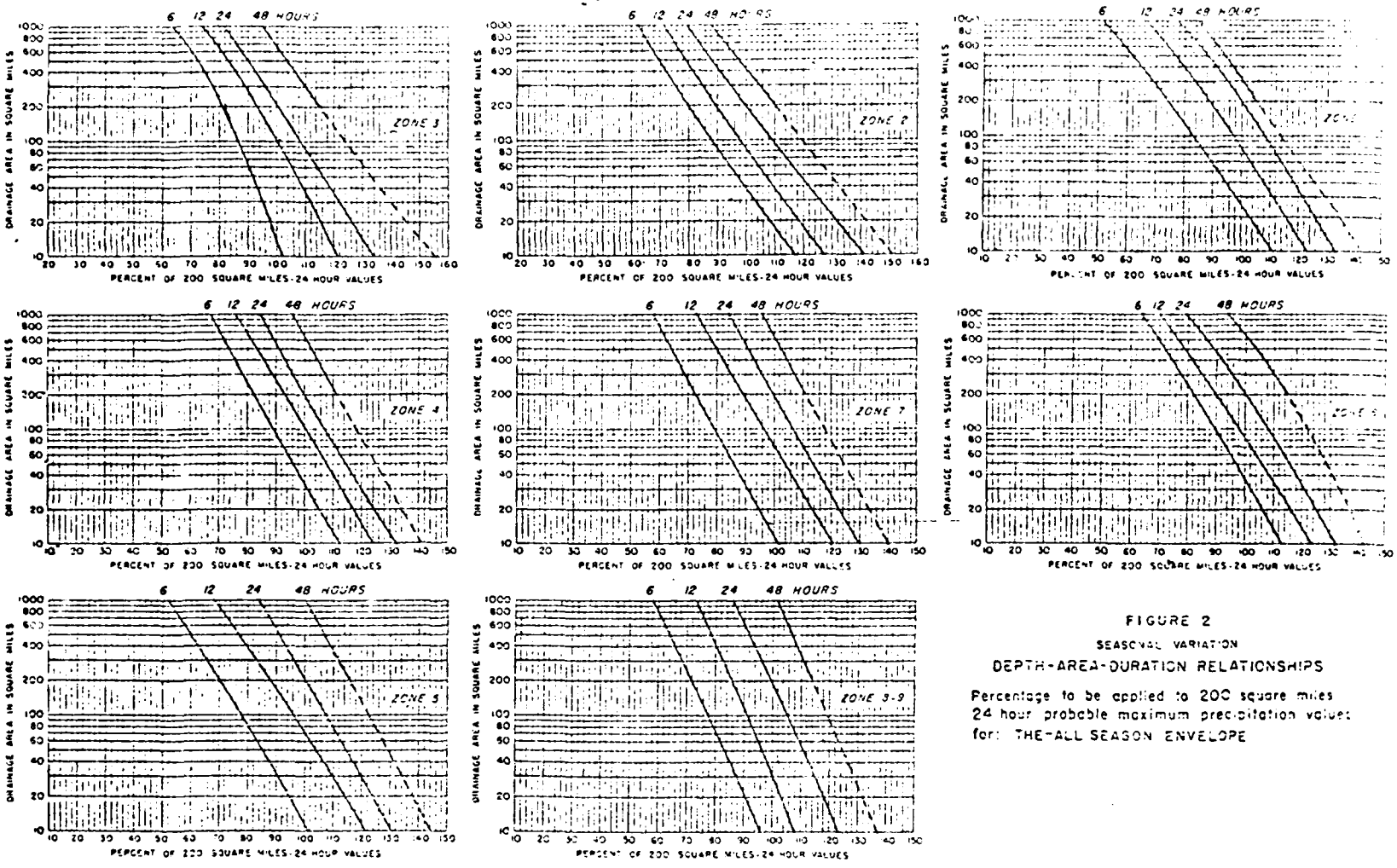


FIGURE 2

SEASONAL VARIATION

DEPTH-AREA-DURATION RELATIONSHIPS

Percentage to be applied to 200 square miles 24 hour probable maximum precipitation values for: THE-ALL SEASON ENVELOPE

ECI-4 **PRC ENGINEERING CONSULTANTS, INC.**

SHEET NO. ____ OF ____

DAM SAFETY INSPECTION — JOB NO. 1263

HAUCK LAKE DAM # 10989 — BY FZ DATE JUNE 80

SERVICE Spillway =

- WEIR FLOW : $Q = C L H^{3/2}$

$C = 3.3$

$L = \frac{21}{12} \times \pi = 5.5$

$H = WSEL - 838$

$\Rightarrow Q = 18.14\, H^{3/2}$

- PRESSURE FLOW

$K_{entrance} = 0.5$

$K_{exit} = 1.0$

$K_{bend + contraction} = 0.5$

$K_{friction} = \frac{29.1\, n^2 L}{R^{4/3}}$ $\quad n = 0.012$ $\quad R = \frac{D}{4}$

$21"\phi \Rightarrow K_f = \left(\frac{10.5}{21}\right)^2 \frac{29.1 \times 0.012^2 \times 10}{(1.75/4)^{4/3}} = 0.03$

$10.5"\phi \Rightarrow K_f = \frac{29.1 \times 0.012^2 \times 91}{(0.875/4)^{4/3}} = 2.89$

$Q = A\sqrt{\frac{2gH}{K}}$

$K = 1 + 0.5 + 0.5 + 0.03 + 2.89 = 4.92$

$H = WSEL - 817 + \frac{10.5}{12} \times \frac{1}{2} = WSEL - 817.44$

$A = 0.6$

$\Rightarrow Q = 2.17\sqrt{H}$

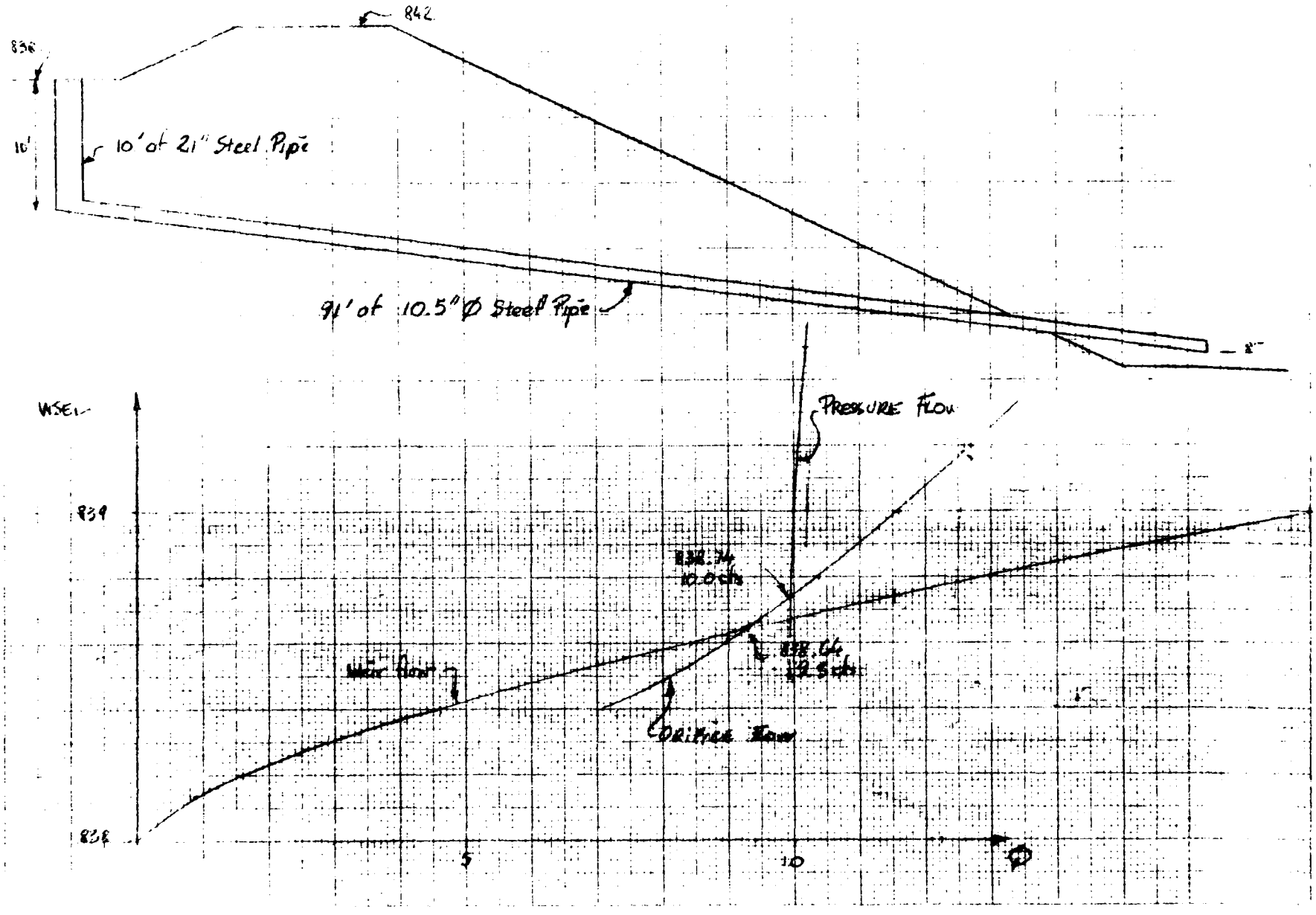
- Check for orifice flow : $Q = 0.6 A \sqrt{2gH}$ $\quad H = WSEL - 838$

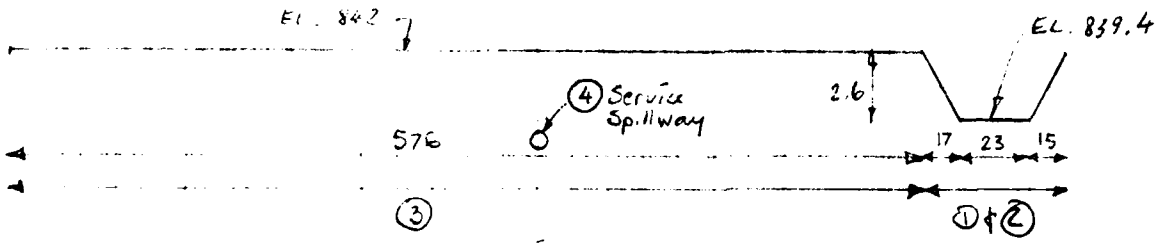
$Q = 0.6 \left(\frac{21}{12}\right)^2 \times \frac{\pi}{4} \sqrt{2gH} = 11.6\sqrt{H}$

. Lower pipe $\quad H = WSEL - 828.4$

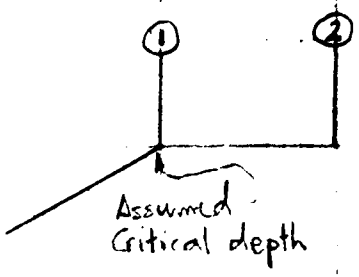
$\Rightarrow Q = 0.6 \left(\frac{10.5}{12}\right)^2 \times \frac{\pi}{4} \sqrt{2gH} = 2.9\sqrt{H}$ does not control

→ see graph.


842
836
10'
10' of 21" Steel Pipe
91' of 10.5"Ø Steel Pipe
WSEL
Pressure Flow
839
838
838.34
10.0 cfs
838.64
12.5 cfs
Weir Flow
Orifice Flow
5
10
Q



①*					②*						WSEC	③			④		Total
y_{c_1}	A_1	T_1	V_1	Q_1	y_2	A_2	T_2	V_2	$V_2^2/2g$	H_2		H_3	C_3	Q_3	H_4	Q_4	Discharge
											838.00				0	0	0
											838.74				21.30	10.0	10.0
											839.40				21.96	10.1	10.0
0.50	13.1	21.2	5.8	50	0.85	24.1	33.5	2.1	.07	0.92	840.32				22.88	10.4	60.
0.99	29.0	35.2	5.2	150	1.47	47.2	41.1	3.2	.16	1.62	841.02				23.58	10.5	161.
1.51	48.8	41.6	6.2	300	2.06	73.5	48.4	4.1	.26	2.32	841.72				24.28	10.7	311.
1.78	60.5	44.9	6.6	400	2.37	89.2	52.2	4.5	.31	2.68	842.08	0.08	2.90	38	24.64	10.8	449
2.02	71.6	48.9	7.0	500	2.64	104.0	55.0	4.8	.36	3.00	842.40	0.40	3.01	439	24.96	10.8	950
2.24	82.4	50.6	7.3	600	2.87	116.7	"	5.1	.41	3.28	842.68	0.68	3.03	979	25.24	10.9	1590
2.62	102.8	55.0	7.8	800	3.26	137.6	"	5.8	.52	3.78	843.18	1.18	3.04	2244	25.74	11.0	3055
2.92	119.2	55.0	8.4	1000	3.60	156.4	"	6.4	.63	4.24	843.64	1.64	3.04	3678	26.20	11.1	4689
3.19	134.1	55.0	9.0	1200	3.92	173.9	"	6.9	.74	4.66	844.06	2.06	3.05	5194	26.62	11.2	6405
3.47	149.0	55.0	9.4	1400	4.22	190.1	"	7.4	.84	5.06	844.46	2.46	3.05	6778	27.02	11.3	8189

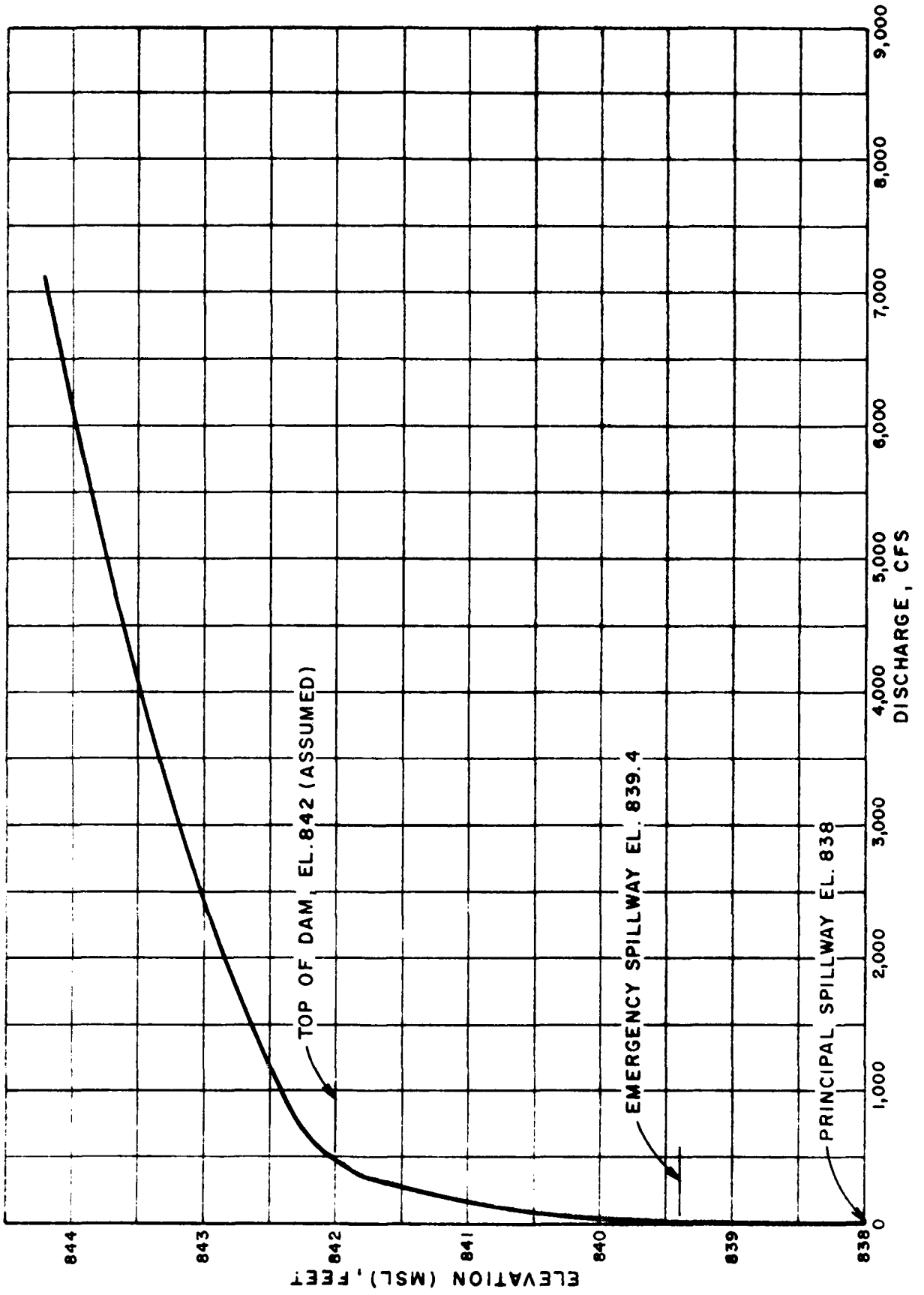


③ $Q_3 = C_3 L_3 H_3^{3/2}$ $L_3 = 576$

$H_3 = H_2 - 2.6$

*See results of HEC2

PLATE 3, APPENDIX B



HAUCK LAKE DAM (MO. 10989)
SPILLWAY & OVERTOP RATING CURVE

ECI-4 **PRC ENGINEERING CONSULTANTS, INC.**

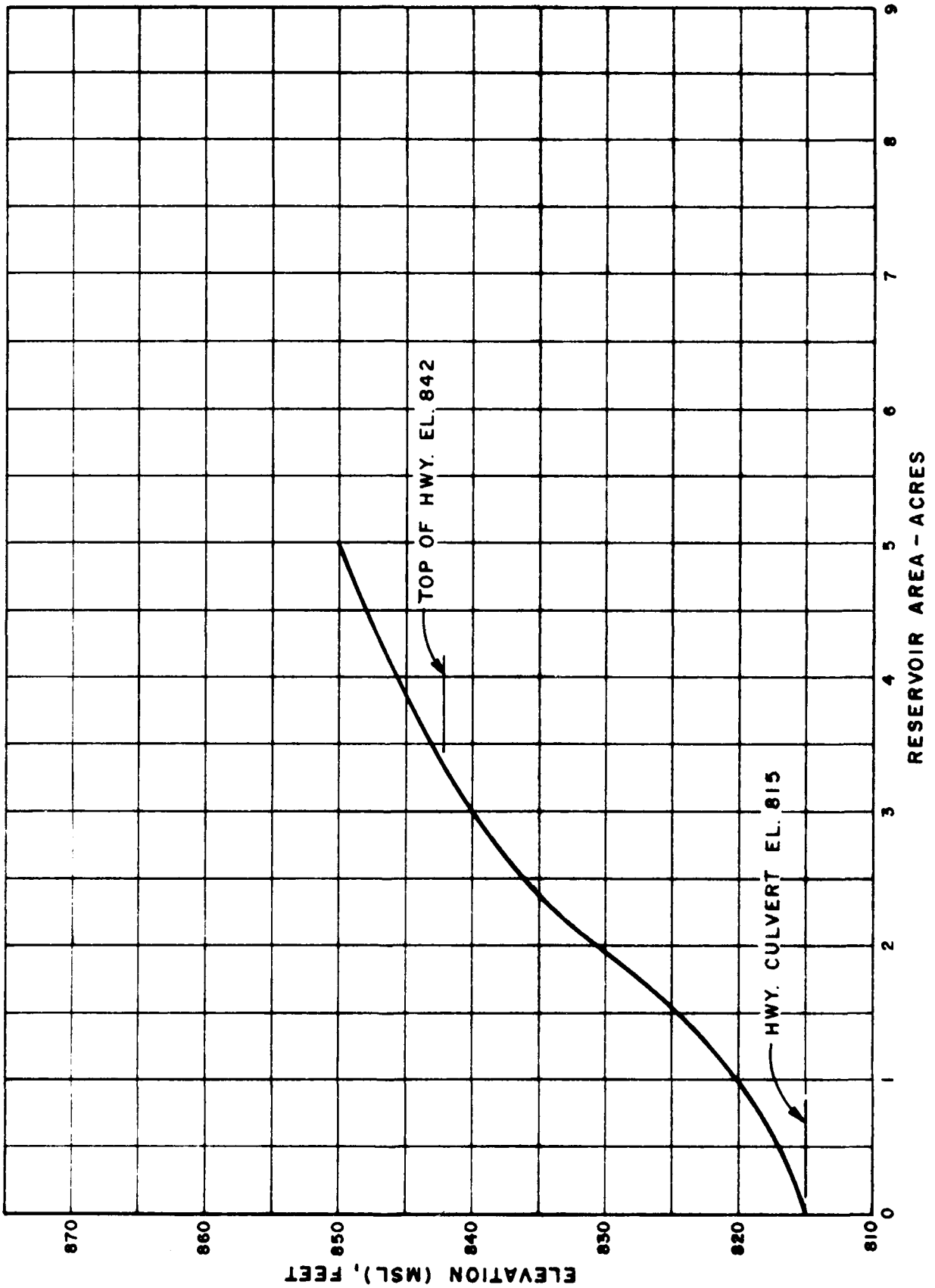
Dam Safety Inspection - Missouri — SHEET NO. ____ OF ____

Dam Name: HWY "F" — ID No.: — JOB NO. 1263

Reservoir Elevation - Area Data — BY FZ — DATE ____

Elev. (M.S.L.) (Ft.)	Reservoir Surface Area (Acres)	Remarks
815	0	Assumed bottom.
820	1	Measured on USGS Quad.
830	2	Interpolated.
840	3	Measured on USGS Quad.
842	3.9	Top of HWY
850	5	Measured on USGS Quad.

PLATE 4, APPENDIX B



HWY. "F" D/S OF HAUCK LAKE DAM
RESERVOIR AREA CURVE

EC1-4 **PRC ENGINEERING CONSULTANTS, INC.**

DAM SAFETY INSPECTION / MISSOURI — SHEET NO. ___ OF ___

DAM NAME: HWY "F" D/S — JOB NO. 1263

UNIT HYDROGRAPH PARAMETERS — BY FZ DATE JUNE 80

1) DRAINAGE AREA, $A = 0.008$ sq. mi = (5 acres)

2) LENGTH OF STREAM, L = ($0.35'' \times 2000' = 700'$) = 0.133 mi.

3) ELEVATION AT DRAINAGE DIVIDE ALONG THE LONGEST STREAM,

$H_1 = 850$

4) ELEVATION OF RESERVOIR AT SPILLWAY CREST, $H_2 = 815$

5) ELEVATION OF CHANNEL BED AT $0.85L$, $E_{85} = 845$

6) ELEVATION OF CHANNEL BED AT $0.10L$, $E_{10} = 818$

7) AVERAGE SLOPE OF THE CHANNEL, $S_{AVG} = (E_{85} - E_{10}) / 0.75L = 0.05$

8) TIME OF CONCENTRATION:

A) BY KIRPICH'S EQUATION,

$$t_c = [(11.9 \times L^3)/(H_1 - H_2)]^{0.385} = \left(\frac{11.9 \times 0.133^3}{850 - 815}\right)^{0.385} = 0.064$$

B) BY VELOCITY ESTIMATE,

SLOPE = 5% $\Rightarrow$ AVG. VELOCITY = 4 fps.

$t_c = L/V = \frac{700}{4} \times \frac{1}{3600} = 0.05$

USE $t_c = 0.064$ hr

9) LAG TIME, $t_l = 0.6\, t_c = 0.039$ hr

10) UNIT DURATION, $D \leq t_l / 3 = 0.013$ hr < 0.083 hr.

USE $D = 0.083$ hr.

11) TIME TO PEAK, $T_p = D/2 + t_l = 0.08$ hr

12) PEAK DISCHARGE,

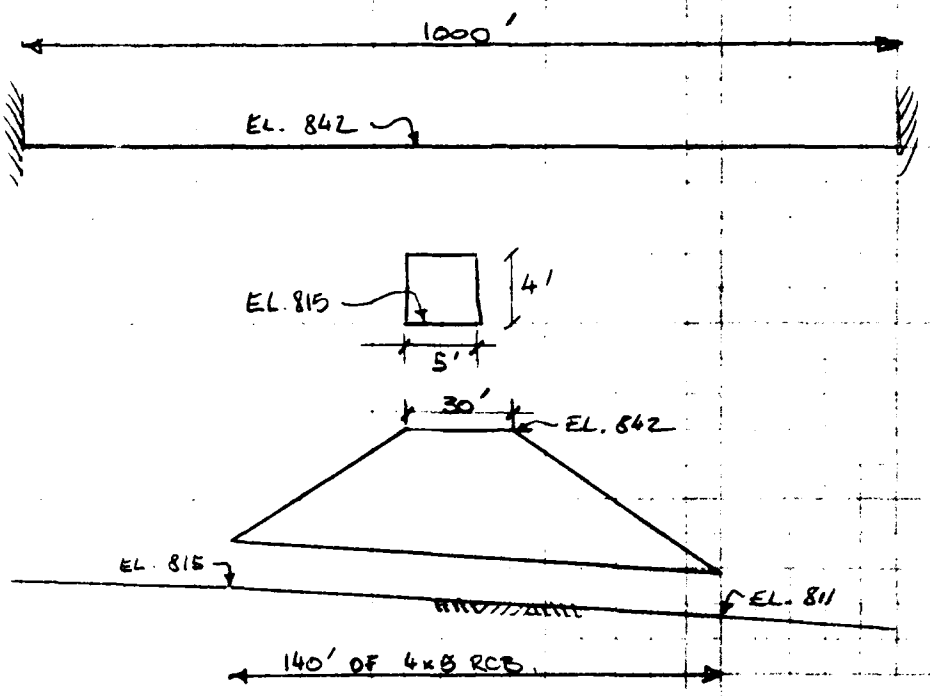
$q_p = (484 \times A) / T_p = 48$ cfs

PRC ENGINEERING CONSULTANTS, INC.

SHEET NO. _____ OF _____

DAM SAFETY INSPECTION — JOB NO. 1263

HWY "F" D/S OF HAUCK LAKE DAM — BY FZ DATE JUNE 80

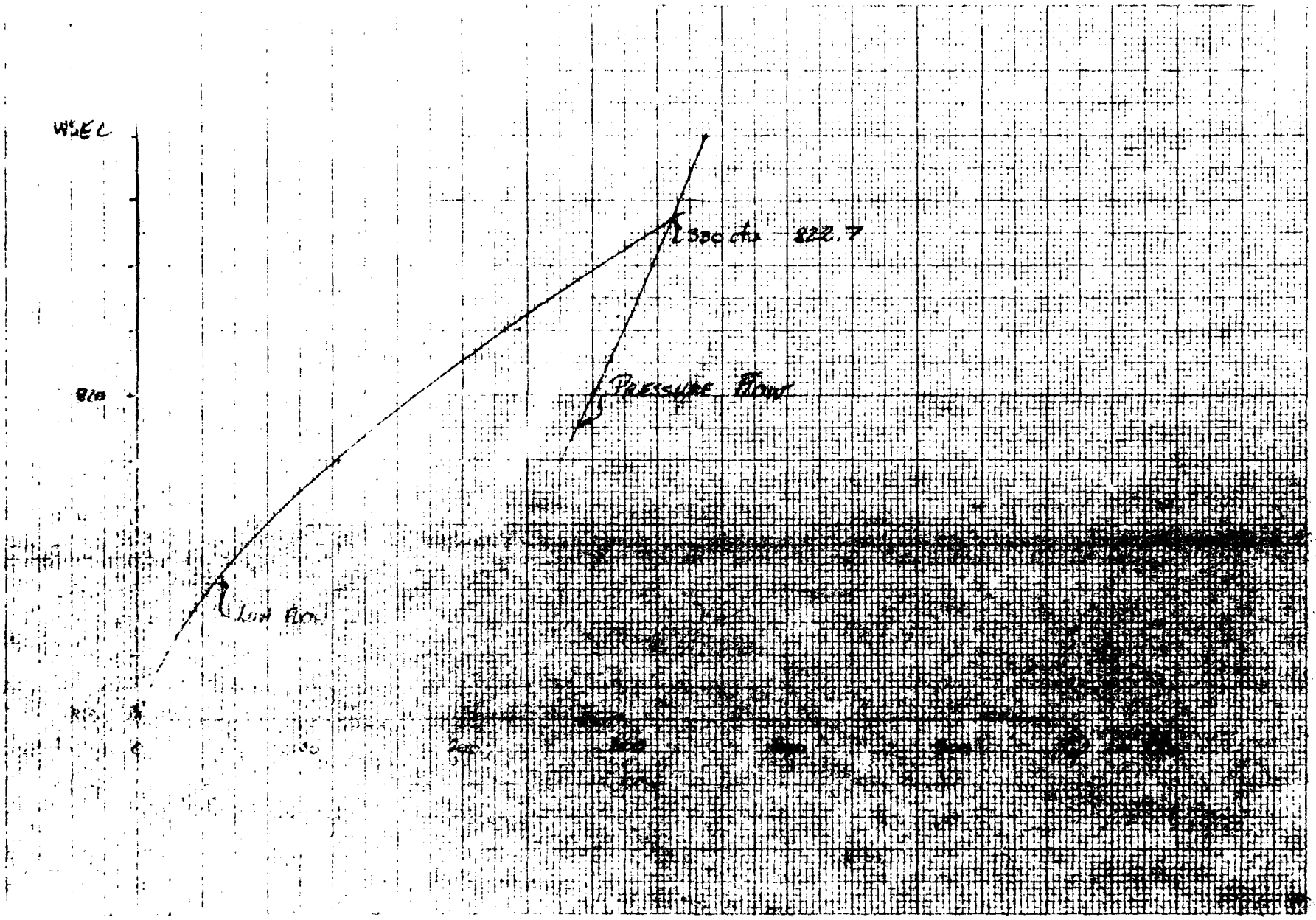


LOW FLOW $S = 0.029$, $n = 0.015$, $A = 5y$, $P = 5 + 2y$ $\Rightarrow Q = \frac{1.49}{n} \times S^{1/2} \times \frac{A^{5/3}}{P^{2/3}}$

y_N	Q	y_c	Regime	
1	67	1.77	Supercritical.	
2	180	3.43	"	⇒ Control at inlet at critical depth.
3	310	4.92	"	

Then $\rightarrow y_c = \frac{2}{3}H$ $\quad H = WSEL - 815$

and $Q = 5\sqrt{y_c^3 g} = 15.444\sqrt{H^3}$


W%EC
810
Low Flow
Pressure Flow
330 cfs 822.7

PRC ENGINEERING CONSULTANTS, INC.

SHEET NO. ____ OF ____

DAM SAFETY INSPECTION — JOB NO. 1263

HWY "F" D/S OF HAUCK LAKE DAM — BY FE DATE JUNE 80

PRESSURE FLOW

$K_{entrance} = 0.5$

$K_{exit} = 1.0$

$K_{friction} = \frac{29.1 n^2 L}{R^{4/3}} = \frac{29.1 \times 0.015^2 \times 140}{(\frac{20}{18})^{4/3}} = 0.8$

$Q = A\sqrt{\frac{2gH}{K_T}}$ $\quad K_T = 2.3$ $\quad H = WSEL - 815$ $\quad \Big\} \; Q = 105.8\sqrt{H}$

WEIR FLOW OVER THE HWY

$Q = C L H^{3/2}$ $\quad L = 1000'$ $\quad H = WSEL - 842$

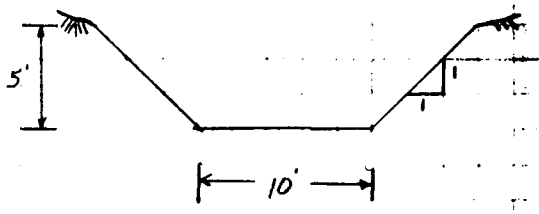
WSEL	5x4 RCB		WEIR			Total Q
	H	Q	H	C	Q	
845	0	0				0
847	2	44				44
849	4	124				124
851.1	9.1	330				330
852	10	461				461
853	29	570	0			570
854.2	29.2	572	0.2	2.97	266	838
854.4	29.4	574	0.4	3.01	762	1336
854.6	29.6	576	0.6	3.03	1408	1984
854.8	29.8	578	0.8	3.03	2168	2746
855	30.	579	1.0	3.03	3030	3609
855.2	30.2	581	1.2	3.04	3996	4577

PRC ENGINEERING CONSULTANTS, INC.

DAM SAFETY INSPECTION / MISSOURI - 1980 SHEET NO. ____ OF ____

HAUCK LAKE DAM (MO. 10989) JOB NO. 1263

CHANNEL CAPACITY D/S OF HWY "F" EMBANKMENT BY JFK DATE 9/17/80



AVERAGE CHANNEL CROSS SECTION

$S_{AVG} = 0.03$

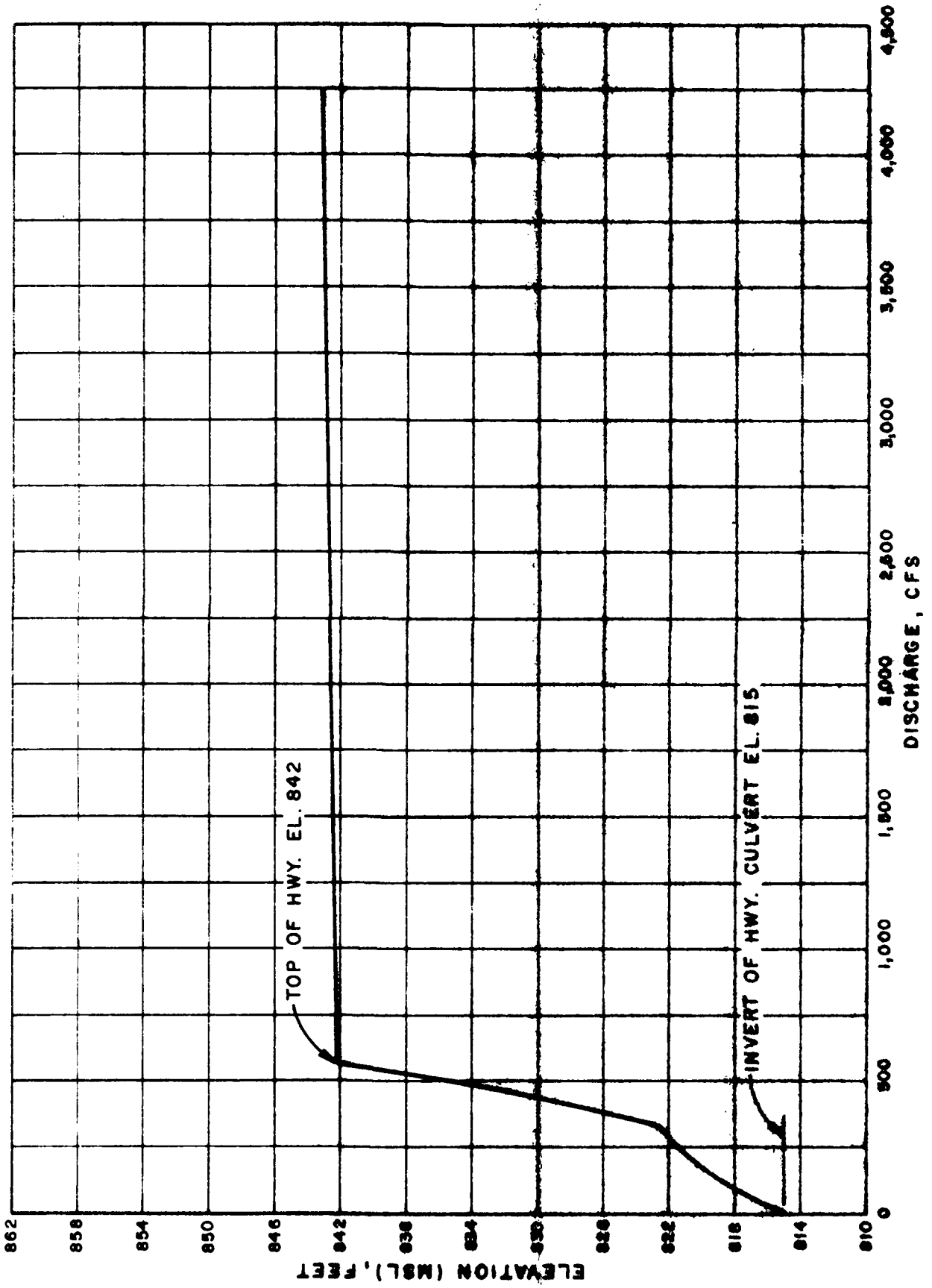
$$Q = \frac{1.49}{n} A R^{2/3} S^{1/2}$$

$$Q = \frac{1.49}{0.04} (75)(3.11)^{2/3} (0.03)^{1/2}$$

$Q = 1{,}030$ cfs

∴ Since the maximum discharge through the culvert is approximately 600 cfs, the D/S channel should be able to carry the flow without causing any tailwater affects at the culvert outlet

PLATE 5, APPENDIX B

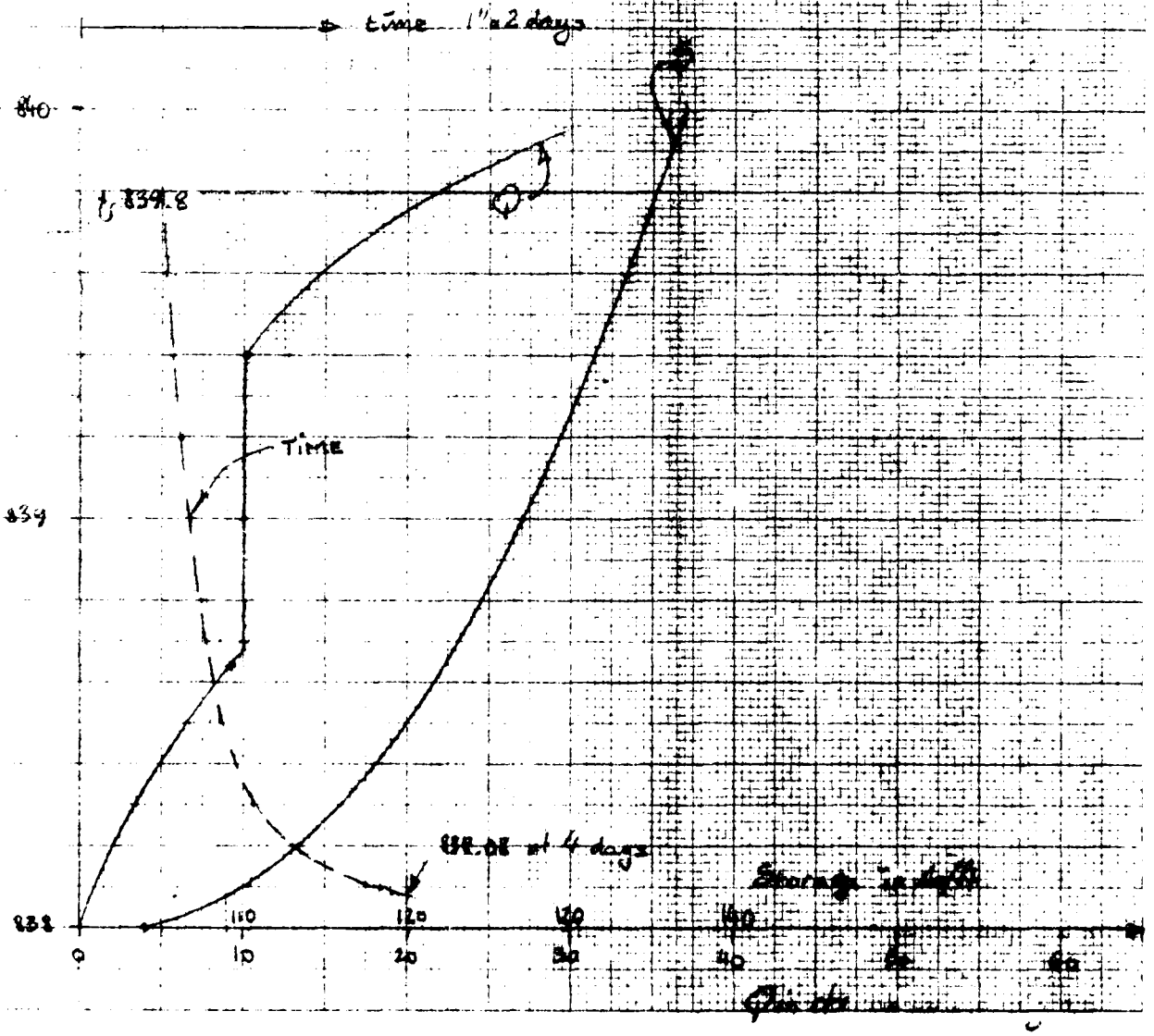


HWY. "F" D/S OF HAUCK LAKE DAM
OVERTOP AND CULVERT RATING CURVE

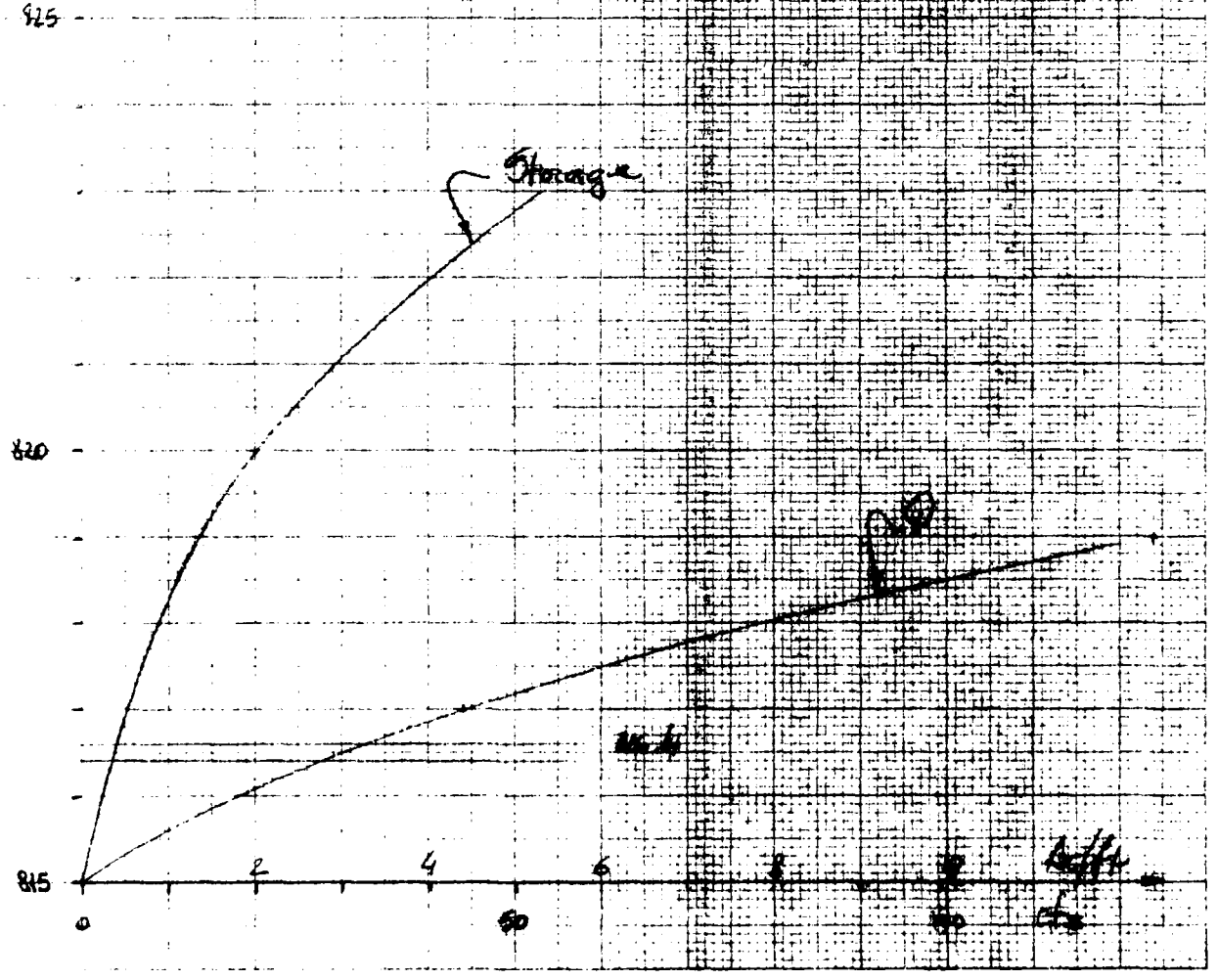
Stage	S	Q	Δt	$\Sigma \Delta t$
839.8	135	22		1
.6	133	15	0.05	1.05
.4	131	10	0.08	1.14
.2	129	10	0.10	1.24
839.0	127	10	0.10	1.34
.8	124	10	0.15	1.49
.7	123	10	0.05	1.54
.5	120	6.5	0.18	1.72
.3	116	3.5	0.40	2.13
.2	113	2	0.55	2.68
.1	110	1	1.01	3.68
838.0	104	0	6.05	9.73

$\Delta t = \frac{2(S_2 - S_1)}{Q_1 + Q_2}$

within less than 1/10 the stage
has back to close to 838 in
four days after the 4 day



Stage	S	Φ	Δt	ΣΔt
	4			
.4	0.35	27	0.	1.0
.2	0.3	22	0.	1.0
816.0	0.25	18	0.	1.0
815.8	0.20	14	0.	1.0
.6	0.15	10	0.	1.01
.4	0.1	6	0.	1.01
.2				
815.0	0	0	0.02	1.03



EC1-4 **PRC ENGINEERING CONSULTANTS, INC.**

DAM SAFETY INSPECTION / MISSOURI SHEET NO. 1 OF 1

DAM NAME: HWY "F", HAUCK LAKE DAM BREACHED JOB NO. 1263

UNIT HYDROGRAPH PARAMETERS BY DATE

1) DRAINAGE AREA, $A = 0.156$ sq. mi = (acres)

2) LENGTH OF STREAM, L = (" × ' = 2300 ') = 0.436 mi.

3) ELEVATION AT DRAINAGE DIVIDE ALONG THE LONGEST STREAM,

$H_1 = 865$

4) ELEVATION OF RESERVOIR AT SPILLWAY CREST, $H_2 = 815$

5) ELEVATION OF CHANNEL BED AT 0.85L, $E_{85} = 860$

6) ELEVATION OF CHANNEL BED AT 0.10L, $E_{10} = 825$

7) AVERAGE SLOPE OF THE CHANNEL, $S_{AVG} = (E_{85} - E_{10}) / 0.75L = 0.02$

8) TIME OF CONCENTRATION:

A) BY KIRPICH'S EQUATION,

$$t_c = [(11.9 \times L^3)/(H_1 - H_2)]^{0.385} = \left(\frac{11.9 \times 0.436^3}{865 - 815}\right)^{0.385} = 0.22 \text{ hr}$$

B) BY VELOCITY ESTIMATE,

SLOPE = 2% ⟹ AVG. VELOCITY = 2.5 fps

$t_c = L/V = 0.25$ hr

USE $t_c = 0.22$ hr

9) LAG TIME, $t_l = 0.6\, t_c = 0.132$

10) UNIT DURATION, $D \leq t_l / 3 = 0.044$ < 0.083 hr.

USE $D = 0.083$

11) TIME TO PEAK, $T_p = D/2 + t_l = 0.174$

12) PEAK DISCHARGE,

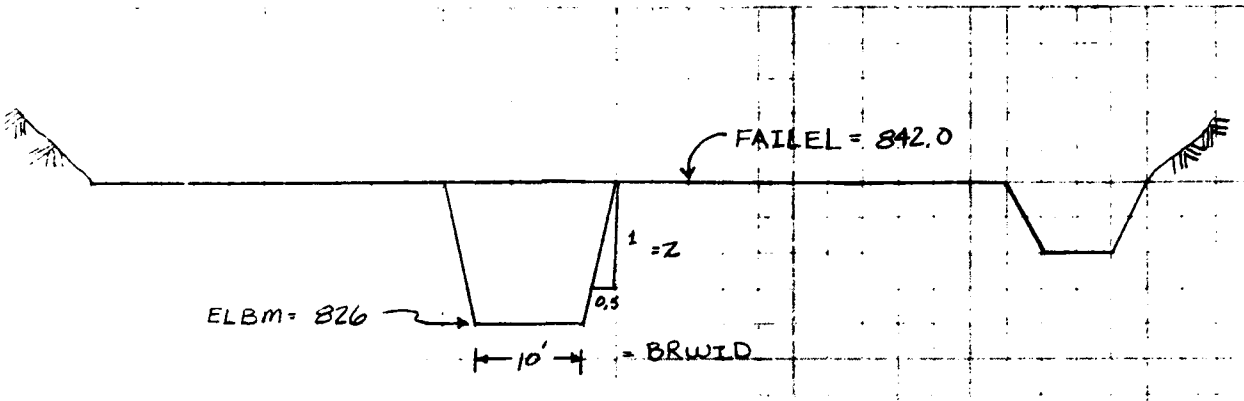
$q_p = (484 \times A) / T_p = 435$ cfs

PRC ENGINEERING CONSULTANTS, INC.

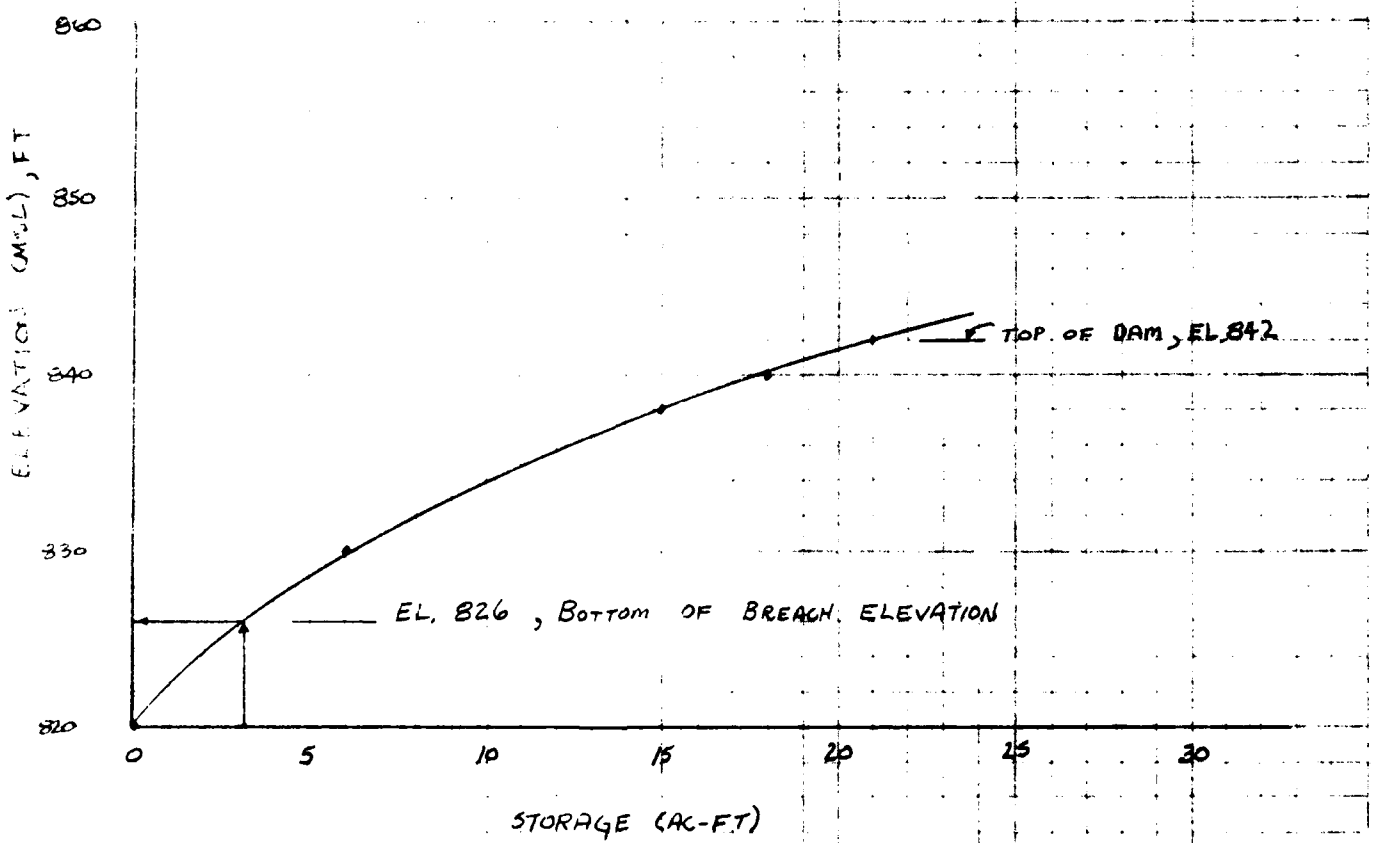
DAM SAFETY INSPECTION / MISSOURI - 1980 — SHEET NO. 1 OF 1

HAUCK LAKE DAM (MO. 10989) — JOB NO. 1263

BREACH PARAMETERS FOR HAUCK LAKE DAM — BY JFK DATE 9/16/80



TFAIL = 1 hr



CAPACITY AT TOP OF DAM = 21 ac-ft

0.15 x 21 = 3.15 ac-ft

HEC1DB INPUT DATA

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**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION:      JULY 1978
  LAST MODIFICATION  26 FEB 79
**********
    1                A1                                   DAM SAFETY INSPECTION - MISSOURI
    2                A2                                      HAUCK LAKE DAM MO.10988
    3                A3                                        PMF AND HALF PMF
    4                J      300        0        5        0        0        0        0        0        0        0
    5                J1       5
    6                J        1        2        1
    7                J1       1      .5
    8                K                DAM                                                1
    9                K1         RUNOFF CALCULATIONS FOR THE MAIN DRAINAGE AREA
   10                M        1        2     .148                .148        1                                 1
   11                P                24.9      100      120      130
   12                T                                                                  -1      -91
   13                M2               .064
   14                K                                  1
   15                K        1       DAM                                               1
   16                K1         ROUTE HYDROGRAPH THROUGH DAM
   17                Y                                                    1        1
   18                Y1       1                                                      -838      -1
   19                Y4     838   838.74   839.40   840.32   841.02   841.72   842.08   842.40   842.68   843.18
   20                Y4843.64   844.06   844.46
   21                Y5       0       10       10       60      161      311      449      950     1590     3055
   22                Y5    4689     6405     8189
   23                BA       0        1        6       15       17       18       21       35       57
   24                BE     820      823      830      838    839.4      840      842      850      860
   25                B$     838
   26                BD     842
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(CONTINUED)

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27                  K          HWY                                                                  1
28                  K1       RUNOFF CALCULATIONS FOR ADDITIONAL DRAINAGE AREA
29                  K        1         2      .008                .008         1                                  1
30                  P                24.9       100       120       130
31                  T                                                                    -1        -91
32                  P2               .039
33                  K                          1
34                  K        2         HWY                                                                  1
35                  K1       COMBINE DAM OUTFLOW AND ADDITIONAL RUNOFF HYDROGRAPHS
36                  K        1         HWY                                                                  1
37                  K1       ROUTE THROUGH HWY CULVERT
38                  K                                              1         1
39                  Y1       1                                                                  -815      -1
40                  Y4       815       817       819     822.7       832       842     842.2     842.4     842.6     842.8
41                  Y4       843     843.2
42                  Y5         0        44       124       330       461       570       838      1336      1984      2746
43                  Y5      3609      4577
44                  E4         0         1         2         3       3.5         5
45                  E5       815       820       830       840       842       850
46                  S3       815
47                  S0       842
48                  K         99
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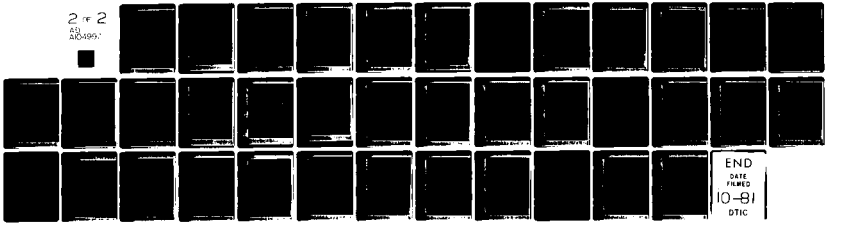
INFLOW PMF AND ONE-HALF PMF HYDROGRAPHS

AD-A104 997 PRC CONSOER TOWNSEND INC ST LOUIS MO F/G 13/13
NATIONAL DAM SAFETY PROGRAM. HAUCK LAKE DAM (MO 10989), MISSOUR--ETC(U)
SEP 80 W G SHIFRIN DACW43-80-C-0094
UNCLASSIFIED NL



PREVIEW OF SEQUENCE OF STREAM NETWORK CALCULATIONS

RUNOFF HYDROGRAPH AT	CAM
ROUTE HYDROGRAPH TO	CAM
RUNOFF HYDROGRAPH AT	HWY
COMBINE 2 HYDROGRAPHS AT	HWY
ROUTE HYDROGRAPH TO	HWY
END OF NETWORK	

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**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
  LAST MODIFICATION  26 FEB 79
**********

RUN DATE= 80/07/16.
TIME= 08.55.17.
```

DAM SAFETY INSPECTION - MISSOURI
HAUCK LAKE DAM NO.10989
PMF AND HALF PMF

JOB SPECIFICATION

NQ	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
300	0	5	0	0	0	0	0	0	0
			JOPER	NWT	LROPT	TRACE			
			5	0	0	0			

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLAN= 1 NRTIO= 2 LRTIO= 1

RTIOS= 1.00 .50

SUB-AREA RUNOFF COMPUTATION

RUNOFF CALCULATIONS FOR THE MAIN DRAINAGE AREA

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
DAM	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	AREA	SNAP	TAREA	TRSPC	RATIO	ISAME	LOCAL
1	2	.15	0.00	.15	1.00	0.000	0	0

PRECIP DATA

SPFE	PMS	R12	R24	R48	R72	R96
0.00	24.90	100.00	100.00	100.00	0.00	0.00	0.00

LOSS DATA

LROPT	STRKR	DLTKR	RTIOK	STRKR	DLTKR	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	1.00	0.00	1.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00

CURVE NO= 91.00 HYDRO= 0.00 PERCENT IMPERVIOUS AREA= 0.00 EFFECTIVE CN = 91.00

UNIT HYDROGRAPH DATA

TP	CP	LAG=
1.00	0.00	.06

RECESSION DATA

STRTQ= 3.00 QRCSN= 0.00 RTIOR= 1.00

UNIT HYDROGRAPH 2 END OF PERIOD ORDINATES, TC= 0.00 HOURS, LAG= .06 VOL= 1.00
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Hii. Jvi. 10. 29. 8. 2.

END-OF-PERIOD FLOW

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
1.01	.05	1	.01	0.00	.01	0.	1.01	12.45	151	.21	.20	.00	830.
1.01	.10	2	.01	0.00	.01	0.	1.01	12.40	152	.21	.20	.00	834.
1.01	.15	3	.01	0.00	.01	0.	1.01	12.45	153	.21	.20	.00	834.
1.01	.20	4	.01	0.00	.01	0.	1.01	12.50	154	.21	.21	.00	834.
1.01	.25	5	.01	0.00	.01	0.	1.01	12.55	155	.21	.20	.00	835.
1.01	.30	6	.01	0.00	.01	0.	1.01	13.00	156	.21	.21	.00	836.
1.01	.35	7	.01	0.00	.01	0.	1.01	13.05	157	.25	.25	.00	840.
1.01	.40	8	.01	0.00	.01	0.	1.01	13.10	158	.25	.25	.00	844.
1.01	.45	9	.01	0.00	.01	0.	1.01	13.15	159	.25	.25	.00	848.
1.01	.50	10	.01	0.00	.01	0.	1.01	13.20	160	.25	.25	.00	852.
1.01	.55	11	.01	0.00	.01	0.	1.01	13.25	161	.25	.25	.00	856.
1.01	1.00	12	.01	0.00	.01	0.	1.01	13.30	162	.25	.25	.00	860.
1.01	1.05	13	.01	0.00	.01	0.	1.01	13.35	163	.25	.25	.00	863.
1.01	1.10	14	.01	0.00	.01	0.	1.01	13.40	164	.25	.25	.00	867.
1.01	1.15	15	.01	.00	.01	0.	1.01	13.45	165	.25	.25	.00	871.
1.01	1.20	16	.01	.00	.01	0.	1.01	13.50	166	.25	.25	.00	875.
1.01	1.25	17	.01	.00	.01	1.	1.01	13.55	167	.25	.25	.00	879.
1.01	1.30	18	.01	.00	.01	1.	1.01	14.00	168	.25	.25	.00	883.
1.01	1.35	19	.01	.00	.01	1.	1.01	14.05	169	.31	.31	.00	891.
1.01	1.40	20	.01	.00	.01	2.	1.01	14.10	170	.31	.31	.00	898.
1.01	1.45	21	.01	.00	.01	2.	1.01	14.15	171	.31	.31	.00	906.
1.01	1.50	22	.01	.00	.01	3.	1.01	14.20	172	.31	.31	.00	914.
1.01	1.55	23	.01	.00	.01	3.	1.01	14.25	173	.31	.31	.00	922.
1.01	2.00	24	.01	.00	.01	3.	1.01	14.30	174	.31	.31	.00	930.
1.01	2.05	25	.01	.00	.01	4.	1.01	14.35	175	.31	.31	.00	938.
1.01	2.10	26	.01	.00	.01	4.	1.01	14.40	176	.31	.31	.00	946.
1.01	2.15	27	.01	.00	.01	4.	1.01	14.45	177	.31	.31	.00	954.
1.01	2.20	28	.01	.00	.01	4.	1.01	14.50	178	.31	.31	.00	962.
1.01	2.25	29	.01	.00	.01	5.	1.01	14.55	179	.31	.31	.00	970.
1.01	2.30	30	.01	.00	.01	5.	1.01	15.00	180	.31	.31	.00	978.
1.01	2.35	31	.01	.00	.01	5.	1.01	15.05	181	.19	.19	.00	981.
1.01	2.40	32	.01	.00	.01	5.	1.01	15.10	182	.38	.38	.00	989.
1.01	2.45	33	.01	.00	.01	6.	1.01	15.15	183	.38	.38	.00	997.
1.01	2.50	34	.01	.00	.01	6.	1.01	15.20	184	.57	.57	.00	1011.
1.01	2.55	35	.01	.00	.01	6.	1.01	15.25	185	.66	.66	.00	1026.
1.01	3.00	36	.01	.00	.01	6.	1.01	15.30	186	1.61	1.60	.00	1318.
1.01	3.05	37	.01	.01	.01	6.	1.01	15.35	187	2.65	2.64	.01	2032.
1.01	3.10	38	.01	.01	.01	7.	1.01	15.40	188	1.04	1.04	.00	2064.
1.01	3.15	39	.01	.01	.01	7.	1.01	15.45	189	.66	.66	.00	2140.
1.01	3.20	40	.01	.01	.01	7.	1.01	15.50	190	.57	.57	.00	2194.
1.01	3.25	41	.01	.01	.01	7.	1.01	15.55	191	.38	.38	.00	2764.
1.01	3.30	42	.01	.01	.01	7.	1.01	16.00	192	.38	.38	.00	4791.
1.01	3.35	43	.01	.01	.01	8.	1.01	16.05	193	.25	.25	.00	5008.
1.01	3.40	44	.01	.01	.01	8.	1.01	16.10	194	.25	.25	.00	5117.
1.01	3.45	45	.01	.01	.01	8.	1.01	16.15	195	.25	.25	.00	5226.
1.01	3.50	46	.01	.01	.01	8.	1.01	16.20	196	.25	.25	.00	5335.
1.01	3.55	47	.01	.01	.01	8.	1.01	16.25	197	.25	.25	.00	5337.
1.01	4.00	48	.01	.01	.01	8.	1.01	16.30	198	.25	.25	.00	5338.
1.01	4.05	49	.01	.01	.01	9.	1.01	16.35	199	.25	.25	.00	5339.
1.01	4.10	50	.01	.01	.01	9.	1.01	16.40	200	.25	.25	.00	5340.
1.01	4.15	51	.01	.01	.01	9.	1.01	16.45	201	.25	.25	.00	5341.
1.01	4.20	52	.01	.01	.01	9.	1.01	16.50	202	.25	.25	.00	5342.
1.01	4.25	53	.01	.01	.01	9.	1.01	16.55	203	.25	.25	.00	5343.
1.01	4.30	54	.01	.01	.01	9.	1.01	17.00	204	.25	.25	.00	5344.
1.01	4.35	55	.01	.01	.01	9.	1.01	17.05	205	.25	.25	.00	5345.

1.01	4.40	56	.01	.01	.01	9.	1.01	17.10	206	.23	.23	.00	270.
1.01	4.45	57	.01	.01	.01	10.	1.01	17.15	207	.23	.23	.00	264.
1.01	4.50	58	.01	.01	.01	10.	1.01	17.20	208	.23	.23	.00	262.
1.01	4.55	59	.01	.01	.01	10.	1.01	17.25	209	.23	.23	.00	261.
1.01	5.00	60	.01	.01	.01	10.	1.01	17.30	210	.23	.23	.00	261.
1.01	5.05	61	.01	.01	.01	10.	1.01	17.35	211	.23	.23	.00	261.
1.01	5.10	62	.01	.01	.01	10.	1.01	17.40	212	.23	.23	.00	261.
1.01	5.15	63	.01	.01	.00	10.	1.01	17.45	213	.23	.23	.00	261.
1.01	5.20	64	.01	.01	.00	10.	1.01	17.50	214	.23	.23	.00	261.
1.01	5.25	65	.01	.01	.00	10.	1.01	17.55	215	.23	.23	.00	261.
1.01	5.30	66	.01	.01	.00	10.	1.01	18.00	216	.23	.23	.00	261.
1.01	5.35	67	.01	.01	.00	10.	1.01	18.05	217	.02	.02	.00	135.
1.01	5.40	68	.01	.01	.00	11.	1.01	18.10	218	.02	.02	.00	53.
1.01	5.45	69	.01	.01	.00	11.	1.01	18.15	219	.02	.02	.00	32.
1.01	5.50	70	.01	.01	.00	11.	1.01	18.20	220	.02	.02	.00	26.
1.01	5.55	71	.01	.01	.00	11.	1.01	18.25	221	.02	.02	.00	24.
1.01	6.00	72	.01	.01	.00	11.	1.01	18.30	222	.02	.02	.00	24.
1.01	6.05	73	.07	.05	.02	35.	1.01	18.35	223	.02	.02	.00	24.
1.01	6.10	74	.07	.05	.02	51.	1.01	18.40	224	.02	.02	.00	24.
1.01	6.15	75	.07	.05	.02	57.	1.01	18.45	225	.02	.02	.00	24.
1.01	6.20	76	.07	.05	.02	59.	1.01	18.50	226	.02	.02	.00	24.
1.01	6.25	77	.07	.05	.02	61.	1.01	18.55	227	.02	.02	.00	24.
1.01	6.30	78	.07	.05	.01	62.	1.01	19.00	228	.02	.02	.00	24.
1.01	6.35	79	.07	.06	.01	63.	1.01	19.05	229	.02	.02	.00	24.
1.01	6.40	80	.07	.06	.01	64.	1.01	19.10	230	.02	.02	.00	24.
1.01	6.45	81	.07	.06	.01	65.	1.01	19.15	231	.02	.02	.00	24.
1.01	6.50	82	.07	.06	.01	66.	1.01	19.20	232	.02	.02	.00	24.
1.01	6.55	83	.07	.06	.01	66.	1.01	19.25	233	.02	.02	.00	24.
1.01	7.00	84	.07	.06	.01	67.	1.01	19.30	234	.02	.02	.00	24.
1.01	7.05	85	.07	.06	.01	68.	1.01	19.35	235	.02	.02	.00	24.
1.01	7.10	86	.07	.06	.01	68.	1.01	19.40	236	.02	.02	.00	24.
1.01	7.15	87	.07	.06	.01	69.	1.01	19.45	237	.02	.02	.00	24.
1.01	7.20	88	.07	.06	.01	69.	1.01	19.50	238	.02	.02	.00	24.
1.01	7.25	89	.07	.06	.01	70.	1.01	19.55	239	.02	.02	.00	24.
1.01	7.30	90	.07	.06	.01	70.	1.01	20.00	240	.02	.02	.00	24.
1.01	7.35	91	.07	.06	.01	71.	1.01	20.05	241	.02	.02	.00	24.
1.01	7.40	92	.07	.06	.01	71.	1.01	20.10	242	.02	.02	.00	24.
1.01	7.45	93	.07	.06	.01	71.	1.01	20.15	243	.02	.02	.00	24.
1.01	7.50	94	.07	.06	.01	72.	1.01	20.20	244	.02	.02	.00	24.
1.01	7.55	95	.07	.06	.01	72.	1.01	20.25	245	.02	.02	.00	24.
1.01	8.00	96	.07	.06	.01	72.	1.01	20.30	246	.02	.02	.00	24.
1.01	8.05	97	.07	.06	.01	73.	1.01	20.35	247	.02	.02	.00	24.
1.01	8.10	98	.07	.06	.01	73.	1.01	20.40	248	.02	.02	.00	24.
1.01	8.15	99	.07	.06	.01	73.	1.01	20.45	249	.02	.02	.00	24.
1.01	8.20	100	.07	.06	.00	73.	1.01	20.50	250	.02	.02	.00	24.
1.01	8.25	101	.07	.06	.00	74.	1.01	20.55	251	.02	.02	.00	24.
1.01	8.30	102	.07	.06	.00	74.	1.01	21.00	252	.02	.02	.00	24.
1.01	8.35	103	.07	.06	.00	74.	1.01	21.05	253	.02	.02	.00	24.
1.01	8.40	104	.07	.06	.00	74.	1.01	21.10	254	.02	.02	.00	24.
1.01	8.45	105	.07	.07	.00	74.	1.01	21.15	255	.02	.02	.00	24.
1.01	8.50	106	.07	.07	.00	75.	1.01	21.20	256	.02	.02	.00	24.
1.01	8.55	107	.07	.07	.00	75.	1.01	21.25	257	.02	.02	.00	24.
1.01	9.00	108	.07	.07	.00	75.	1.01	21.30	258	.02	.02	.00	24.
1.01	9.05	109	.07	.07	.00	75.	1.01	21.35	259	.02	.02	.00	24.
1.01	9.10	110	.07	.07	.00	75.	1.01	21.40	260	.02	.02	.00	24.
1.01	9.15	111	.07	.07	.00	75.	1.01	21.45	261	.02	.02	.00	24.
1.01	9.20	112	.07	.07	.00	75.	1.01	21.50	262	.02	.02	.00	24.
1.01	9.25	113	.07	.07	.00	75.	1.01	21.55	263	.02	.02	.00	24.
1.01	9.30	114	.07	.07	.00	75.	1.01	22.00	264	.02	.02	.00	24.
1.01	9.35	115	.07	.07	.00	75.	1.01	22.05	265	.02	.02	.00	24.

1.01	9.40	116	.07	.07	.00	76.	1.01	22.10	266	.02	.02	.00	24.
1.01	9.45	117	.07	.07	.00	76.	1.01	22.15	267	.02	.02	.00	24.
1.01	9.50	118	.07	.07	.00	76.	1.01	22.20	268	.02	.02	.00	24.
1.01	9.55	119	.07	.07	.00	76.	1.01	22.25	269	.02	.02	.00	24.
1.01	10.00	120	.07	.07	.00	76.	1.01	22.30	270	.02	.02	.00	24.
1.01	10.05	121	.07	.07	.00	76.	1.01	22.35	271	.02	.02	.00	24.
1.01	10.10	122	.07	.07	.00	76.	1.01	22.40	272	.02	.02	.00	24.
1.01	10.15	123	.07	.07	.00	76.	1.01	22.45	273	.02	.02	.00	24.
1.01	10.20	124	.07	.07	.00	76.	1.01	22.50	274	.02	.02	.00	24.
1.01	10.25	125	.07	.07	.00	77.	1.01	22.55	275	.02	.02	.00	24.
1.01	10.30	126	.07	.07	.00	77.	1.01	23.00	276	.02	.02	.00	24.
1.01	10.35	127	.07	.07	.00	77.	1.01	23.05	277	.02	.02	.00	24.
1.01	10.40	128	.07	.07	.00	77.	1.01	23.10	278	.02	.02	.00	24.
1.01	10.45	129	.07	.07	.00	77.	1.01	23.15	279	.02	.02	.00	24.
1.01	10.50	130	.07	.07	.00	77.	1.01	23.20	280	.02	.02	.00	24.
1.01	10.55	131	.07	.07	.00	77.	1.01	23.25	281	.02	.02	.00	24.
1.01	11.00	132	.07	.07	.00	77.	1.01	23.30	282	.02	.02	.00	24.
1.01	11.05	133	.07	.07	.00	77.	1.01	23.35	283	.02	.02	.00	24.
1.01	11.10	134	.07	.07	.00	77.	1.01	23.40	284	.02	.02	.00	24.
1.01	11.15	135	.07	.07	.00	77.	1.01	23.45	285	.02	.02	.00	24.
1.01	11.20	136	.07	.07	.00	77.	1.01	23.50	286	.02	.02	.00	24.
1.01	11.25	137	.07	.07	.00	77.	1.01	23.55	287	.02	.02	.00	24.
1.01	11.30	138	.07	.07	.00	77.	1.02	0.00	288	.02	.02	.00	24.
1.01	11.35	139	.07	.07	.00	77.	1.02	.05	289	0.00	0.00	0.00	11.
1.01	11.40	140	.07	.07	.00	77.	1.02	.10	290	0.00	0.00	0.00	3.
1.01	11.45	141	.07	.07	.00	77.	1.02	.15	291	0.00	0.00	0.00	1.
1.01	11.50	142	.07	.07	.00	77.	1.02	.20	292	0.00	0.00	0.00	0.
1.01	11.55	143	.07	.07	.00	77.	1.02	.25	293	0.00	0.00	0.00	0.
1.01	12.00	144	.07	.07	.00	77.	1.02	.30	294	0.00	0.00	0.00	0.
1.01	12.05	145	.21	.20	.00	160.	1.02	.35	295	0.00	0.00	0.00	0.
1.01	12.10	146	.21	.20	.00	213.	1.02	.40	296	0.00	0.00	0.00	0.
1.01	12.15	147	.21	.20	.00	228.	1.02	.45	297	0.00	0.00	0.00	0.
1.01	12.20	148	.21	.20	.00	238.	1.02	.50	298	0.00	0.00	0.00	0.
1.01	12.25	149	.21	.20	.00	252.	1.02	.55	299	0.00	0.00	0.00	0.
1.01	12.30	150	.21	.20	.00	254.	1.02	1.00	300	0.00	0.00	0.00	0.
									SUM	32.37	31.81	1.16	35764.
										(822.)	(795.)	29.5	(1012.73)

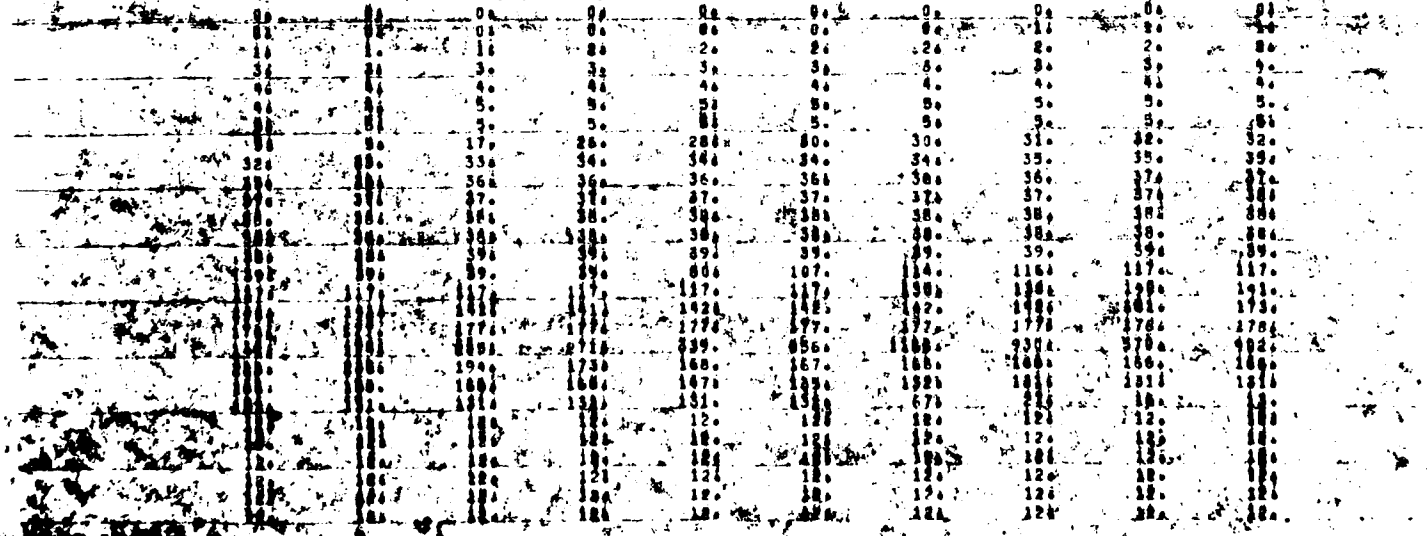
	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	2332.	3936	184.	119.	35755.
CMS	66.	111.	4.	3.	1012.
INCHES		.07	.81	.81	31.81
MM		826.70	792.80	792.80	792.80
AC-FT		1954.	246.	246.	246.
THOUS CU M		240.	304.	304.	304.

HYDROGRAPH AT STA DAM FOR PLAN 1, RATIO 1

74.	74.	74.	74.	74.	75.	75.	75.	75.	75.
75.	75.	75.	76.	76.	76.	76.	76.	76.	76.
76.	76.	76.	76.	77.	77.	77.	77.	77.	77.
77.	77.	77.	77.	77.	77.	77.	77.	77.	77.
77.	77.	77.	77.	160.	213.	288.	332.	333.	334.
234.	234.	234.	235.	235.	235.	260.	276.	281.	282.
282.	283.	283.	283.	283.	288.	283.	283.	321.	345.
332.	354.	355.	355.	355.	359.	355.	355.	355.	355.
281.	349.	410.	541.	677.	1312.	2332.	1861.	1140.	886.
576.	470.	388.	347.	336.	333.	332.	332.	332.	332.
332.	332.	332.	332.	298.	270.	264.	262.	261.	261.
261.	261.	261.	261.	241.	261.	135.	53.	32.	26.
24.	24.	24.	24.	24.	24.	24.	24.	24.	24.
24.	24.	24.	24.	24.	24.	24.	24.	24.	24.
24.	24.	24.	24.	24.	24.	24.	24.	24.	24.
24.	24.	24.	24.	24.	24.	24.	24.	24.	24.
24.	24.	24.	24.	24.	24.	24.	24.	24.	24.
24.	24.	24.	24.	24.	24.	24.	24.	24.	24.
24.	24.	24.	24.	24.	24.	24.	24.	24.	24.
24.	24.	24.	24.	24.	24.	24.	24.	11.	3.
1.	0.	0.	0.	0.	0.	0.	0.	0.	0.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	2332.	393.	124.	119.	35759.
CMS	66.	11.	4.	3.	1012.
INCHES		24.67	31.21	31.21	31.21
MM		626.70	792.80	792.80	792.80
AC-FT		195.	246.	246.	246.
THOUS CU M		240.	304.	304.	304.

HYDROGRAPH AT STA DAM FOR PLAN 1, RTIO 2



PMF AND ONE-HALF PMF ROUTING

12.	12.	12.	12.	12.	12.	12.	12.	5.	1.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	1168.	196.	62.	60.	17877.
CMS	33.	6.	2.	2.	506.
INCHES		12.34	15.61	15.61	15.61
MM		313.35	396.40	396.40	396.40
AC-FT		97.	123.	123.	123.
THOUS CU M		120.	152.	152.	152.

********** ********** ********** ********** **********

HYDROGRAPH ROUTING

ROUTE HYDROGRAPH THROUGH DAM

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
DAM	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP		LSTR
0.0	0.000	0.00	1	1	0	0		0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	-838.	-1

STAGE 838.00 838.74 839.40 840.32 841.02 841.72 842.08 [illegible] [illegible] [illegible]
843.64 844.06 844.46

FLOW [illegible] [illegible] 10.00 [illegible] [illegible] [illegible] 449.00 [illegible] [illegible] [illegible]
[illegible] [illegible] [illegible]

SURFACE AREA [illegible] 6. [illegible] [illegible] 15. [illegible] 18. 21. 38. 57.

CAPACITY [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible]

ELEVATION [illegible] 823. 830. 838. 839. 840. 842. [illegible] [illegible]

CREL	SPWID	COQW	EXPW	ELEVL	COOL	CAREA	EXPL
[illegible]	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

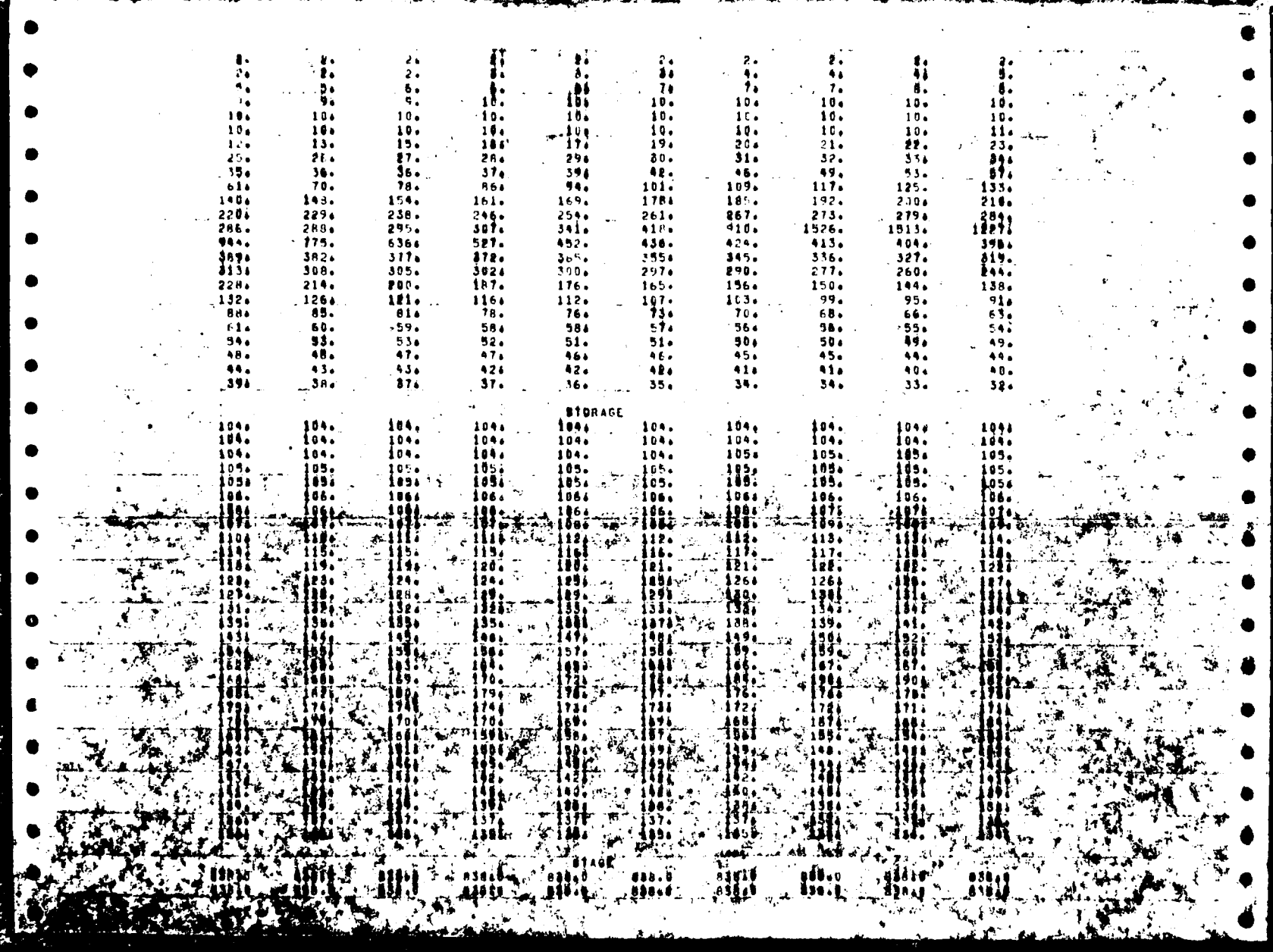
TOPEL	COOD	EXPD	DAMWID
[illegible]	[illegible]	0.0	0.

STATION DAM, PLAN 1, RATIO 1

END-OF-PERIOD HYDROGRAPH ORDINATES

OUTFLOW

[illegible]


STORAGE

STORAGE

838.2	838.3	838.3	838.4	838.4	838.4	838.4	838.4	838.4	838.4
838.5	838.5	838.5	838.5	838.5	838.5	838.5	838.6	838.6	838.6
838.6	838.6	838.6	838.6	838.6	838.7	838.7	838.7	838.7	838.7
838.7	838.7	838.7	838.8	838.8	838.8	838.8	838.8	838.8	838.8
838.8	838.8	838.9	838.9	838.9	838.9	838.9	838.9	838.9	838.9
839.0	839.0	839.0	839.0	839.0	839.0	839.1	839.1	839.2	839.2
839.3	839.3	839.4	839.4	839.4	839.5	839.5	839.6	839.6	839.7
839.7	839.8	839.8	839.8	839.9	839.9	840.0	840.0	840.0	840.1
840.1	840.2	840.2	840.3	840.3	840.4	840.4	840.4	840.5	840.5
840.5	840.6	840.6	840.6	840.7	840.8	841.1	841.4	841.6	841.6
841.7	841.6	841.6	841.6	841.5	841.5	841.5	841.4	841.4	841.4
841.4	841.3	841.3	841.3	841.3	841.3	841.2	841.2	841.2	841.2
841.1	841.1	841.1	841.1	841.1	841.1	841.0	841.0	840.9	840.9
840.9	840.8	840.8	840.7	840.7	840.7	840.6	840.6	840.6	840.6
840.5	840.5	840.4	840.4	840.4	840.4	840.4	840.3	840.3	840.3
840.3	840.3	840.3	840.2	840.2	840.2	840.2	840.2	840.2	840.1
840.1	840.1	840.1	840.1	840.1	840.1	840.0	840.0	840.0	840.0
840.0	840.0	840.0	840.0	840.0	839.9	839.9	839.9	839.9	839.9
839.9	839.9	839.9	839.9	839.9	839.8	839.8	839.8	839.8	839.8
839.8	839.8	839.8	839.8	839.8	839.8	839.8	839.8	839.7	839.7
839.7	839.7	839.7	839.7	839.7	839.7	839.7	839.7	839.6	839.6

PEAK OUTFLOW IS 296. AT TIME 15.92 HOURS

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	296.	150.	49.	47.	14050.
CMS	8.	4.	1.	1.	398.
INCHES		9.41	12.26	12.26	12.26
MM		239.02	311.53	311.53	311.53
AC-FT		74.	97.	97.	97.
THOUS CU M		92.	119.	119.	119.

SUB-AREA RUNOFF COMPUTATION

RUNOFF CALCULATIONS FOR ADDITIONAL DRAINAGE AREA

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
HYD	0	0	0	0	0	0	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	IRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	1	.01	0.00	.01	1.00	0.000	0	1	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	24.90	100.00	120.00	130.00	0.00	0.00	0.00

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOR	STRTL	CNSTL	ALSMX	RTIMP
0	1.00	0.00	1.00	0.00	0.00	1.00	0.00	91.00	0.00	0.00

CURVE NO = 91.00 WETNESS = 91.00 EFFECT CN = 91.00

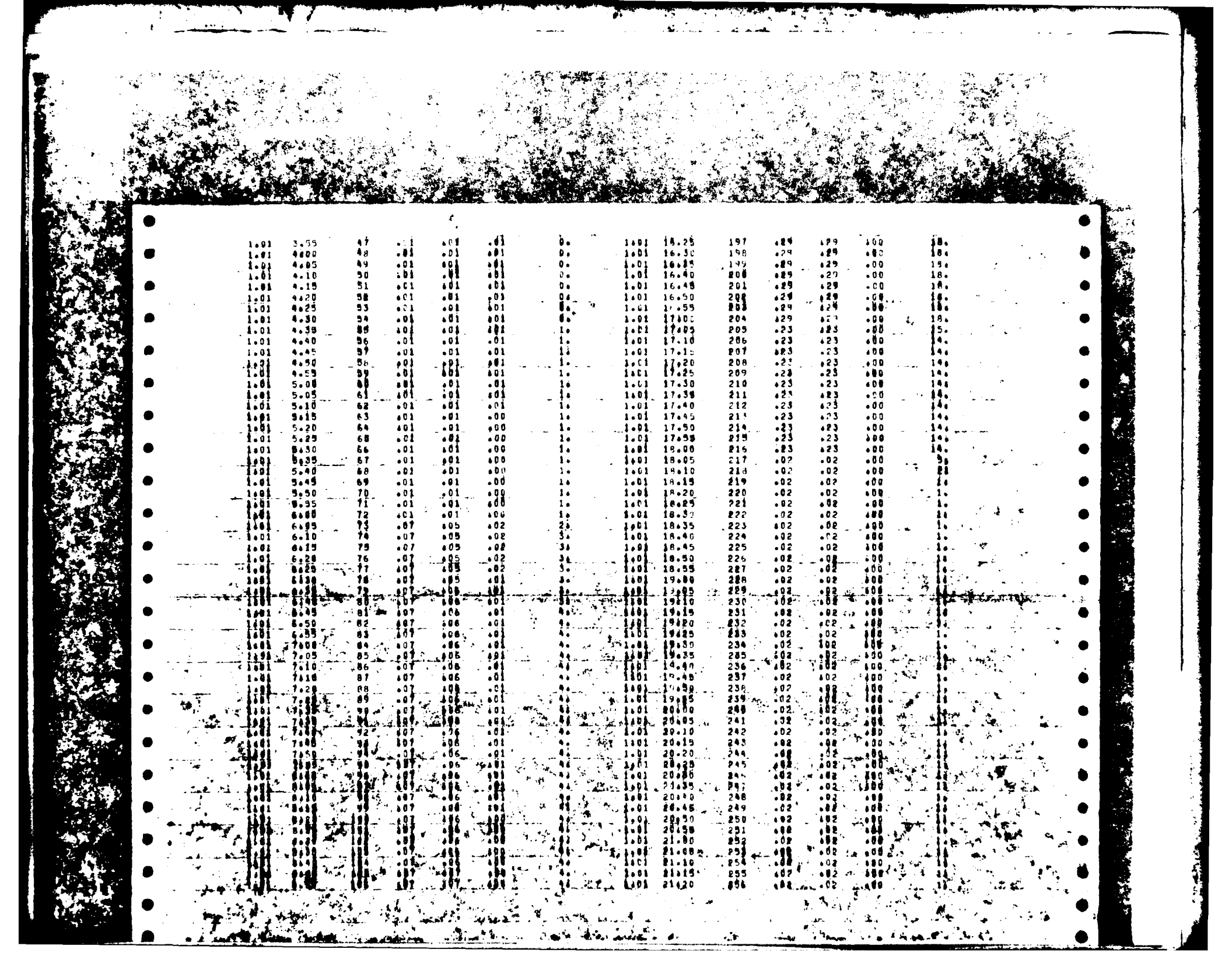
UNIT HYDROGRAPH DATA
TC= 0.00 LAG= .04

RECESSION DATA
STRTQ= 0.00 QRCSN= 0.00 RTIOR= 1.00

TIME INCREMENT TOO LARGE--INHG IS .01 LAG/2)

UNIT HYDROGRAPH 5 END OF PERIOD ORDINATES, TC= 0.00 HOURS, LAG= .04, VOL= 1.00
46. 13. 3. 1. 0.

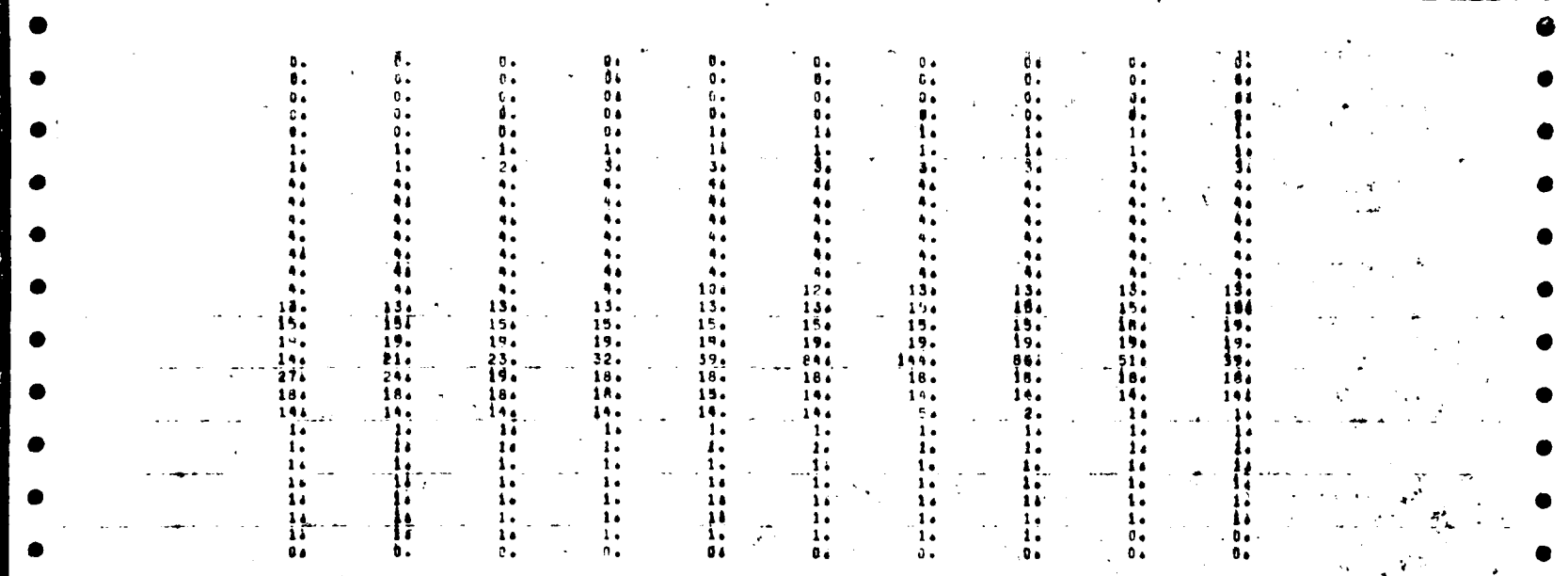
MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	END-OF-PERIOD FLOW COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
1.01	.05	1	.01	0.00	.01	0.	1.01	12.55	151	.21	.20	.00	13.
1.01	.10	2	.01	0.00	.01	0.	1.01	13.00	152	.21	.20	.00	13.
1.01	.15	3	.01	0.00	.01	0.	1.01	13.05	153	.21	.20	.00	13.
1.01	.20	4	.01	0.00	.01	0.	1.01	13.10	154	.21	.20	.00	13.
1.01	.25	5	.01	0.00	.01	0.	1.01	13.15	155	.21	.20	.00	13.
1.01	.30	6	.01	0.00	.01	0.	1.01	13.20	156	.21	.21	.00	13.
1.01	.35	7	.01	0.00	.01	0.	1.01	13.25	157	.25	.25	.00	16.
1.01	.40	8	.01	0.00	.01	0.	1.01	13.30	158	.25	.25	.00	15.
1.01	.45	9	.01	0.00	.01	0.	1.01	13.35	159	.25	.25	.00	15.
1.01	.50	10	.01	0.00	.01	0.	1.01	13.40	160	.25	.25	.00	15.
1.01	.55	11	.01	0.00	.01	0.	1.01	13.45	161	.25	.25	.00	15.
1.01	1.00	12	.01	0.00	.01	0.	1.01	13.50	162	.25	.25	.00	15.
1.01	1.05	13	.01	0.00	.01	0.	1.01	13.55	163	.25	.25	.00	15.
1.01	1.10	14	.01	0.00	.01	0.	1.01	14.00	164	.25	.25	.00	15.
1.01	1.15	15	.01	.00	.01	0.	1.01	14.05	165	.25	.25	.00	15.
1.01	1.20	16	.01	.00	.01	0.	1.01	14.10	166	.25	.25	.00	15.
1.01	1.25	17	.01	.00	.01	0.	1.01	14.15	167	.25	.25	.00	15.
1.01	1.30	18	.01	.00	.01	0.	1.01	14.20	168	.25	.25	.00	15.
1.01	1.35	19	.01	.00	.01	0.	1.01	14.25	169	.25	.25	.00	15.
1.01	1.40	20	.01	.00	.01	0.	1.01	14.30	170	.25	.25	.00	15.
1.01	1.45	21	.01	.00	.01	0.	1.01	14.35	171	.25	.25	.00	15.
1.01	1.50	22	.01	.00	.01	0.	1.01	14.40	172	.31	.31	.00	19.
1.01	1.55	23	.01	.00	.01	0.	1.01	14.45	173	.31	.31	.00	19.
1.01	2.00	24	.01	.00	.01	0.	1.01	14.50	174	.31	.31	.00	19.
1.01	2.05	25	.01	.00	.01	0.	1.01	14.55	175	.31	.31	.00	19.
1.01	2.10	26	.01	.00	.01	0.	1.01	15.00	176	.31	.31	.00	19.
1.01	2.15	27	.01	.00	.01	0.	1.01	15.05	177	.31	.31	.00	19.
1.01	2.20	28	.01	.00	.01	0.	1.01	15.10	178	.31	.31	.00	19.
1.01	2.25	29	.01	.00	.01	0.	1.01	15.15	179	.31	.31	.00	19.
1.01	2.30	30	.01	.00	.01	0.	1.01	15.20	180	.38	.38	.00	23.
1.01	2.35	31	.01	.00	.01	0.	1.01	15.25	181	.38	.38	.00	23.
1.01	2.40	32	.01	.00	.01	0.	1.01	15.30	182	.38	.38	.00	23.
1.01	2.45	33	.01	.00	.01	0.	1.01	15.35	183	.38	.38	.00	23.
1.01	2.50	34	.01	.00	.01	0.	1.01	15.40	184	.38	.38	.00	23.
1.01	2.55	35	.01	.00	.01	0.	1.01	15.45	185	.38	.38	.00	23.
1.01	3.00	36	.01	.00	.01	0.	1.01	15.50	186	1.61	1.60	.01	97.
1.01	3.05	37	.01	.00	.01	0.	1.01	15.55	187	.04	.03	.01	97.
1.01	3.10	38	.01	.00	.01	0.	1.01	16.00	188	1.04	1.04	.00	100.
1.01	3.15	39	.01	.00	.01	0.	1.01	16.05	189	.04	.03	.01	100.
1.01	3.20	40	.01	.00	.01	0.	1.01	16.10	190	.04	.03	.01	100.
1.01	3.25	41	.01	.00	.01	0.	1.01	16.15	191	.04	.03	.01	100.
1.01	3.30	42	.01	.00	.01	0.	1.01	16.20	192	.04	.03	.01	100.
1.01	3.35	43	.01	.00	.01	0.	1.01	16.25	193	.04	.03	.01	100.
1.01	3.40	44	.01	.00	.01	0.	1.01	16.30	194	.04	.03	.01	100.
1.01	3.45	45	.01	.00	.01	0.	1.01	16.35	195	.04	.03	.01	100.
1.01	3.50	46	.01	.00	.01	0.	1.01	16.40	196	.04	.03	.01	100.



1.01	9.55	107	.07	.07	.00	4.	1.01	21.25	257	.02	.02	.00		1.
1. 1	9.00	108	.07	.07	.00	4.	1.01	21.30	258	.02	.02	.00		1.
1.01	9.05	109	.07	.07	.00	4.	1.01	21.35	259	.02	.02	.00		1.
1.01	9.10	110	.07	.07	.00	4.	1.01	21.40	260	.02	.02	.00		1.
1.01	9.15	111	.07	.07	.00	4.	1.01	21.45	261	.02	.02	.00		1.
1.01	9.20	112	.07	.07	.00	4.	1.01	21.50	262	.02	.02	.00		1.
1.01	9.25	113	.07	.07	.00	4.	1.01	21.55	263	.02	.02	.00		1.
1.01	9.30	114	.07	.07	.00	4.	1.01	22.00	264	.02	.02	.00		1.
1.01	9.35	115	.07	.07	.00	4.	1.01	22.05	265	.02	.02	.00		1.
1.01	9.40	116	.07	.07	.00	4.	1.01	22.10	266	.02	.02	.00		1.
1.01	9.45	117	.07	.07	.00	4.	1.01	22.15	267	.02	.02	.00		1.
1.01	9.50	118	.07	.07	.00	4.	1.01	22.20	268	.02	.02	.00		1.
1.01	9.55	119	.07	.07	.00	4.	1.01	22.25	269	.02	.02	.00		1.
1.01	10.00	120	.07	.07	.00	4.	1.01	22.30	270	.02	.02	.00		1.
1.01	10.05	121	.07	.07	.00	4.	1.01	22.35	271	.02	.02	.00		1.
1.01	10.10	122	.07	.07	.00	4.	1.01	22.40	272	.02	.02	.00		1.
1.01	10.15	123	.07	.07	.00	4.	1.01	22.45	273	.02	.02	.00		1.
1.01	10.20	124	.07	.07	.00	4.	1.01	22.50	274	.02	.02	.00		1.
1.01	10.25	125	.07	.07	.00	4.	1.01	22.55	275	.02	.02	.00		1.
1.01	10.30	126	.07	.07	.00	4.	1.01	23.00	276	.02	.02	.00		1.
1.01	10.35	127	.07	.07	.00	4.	1.01	23.05	277	.02	.02	.00		1.
1.01	10.40	128	.07	.07	.00	4.	1.01	23.10	278	.02	.02	.00		1.
1.01	10.45	129	.07	.07	.00	4.	1.01	23.15	279	.02	.02	.00		1.
1.01	10.50	130	.07	.07	.00	4.	1.01	23.20	280	.02	.02	.00		1.
1.01	10.55	131	.07	.07	.00	4.	1.01	23.25	281	.02	.02	.00		1.
1.01	11.00	132	.07	.07	.00	4.	1.01	23.30	282	.02	.02	.00		1.
1.01	11.05	133	.07	.07	.00	4.	1.01	23.35	283	.02	.02	.00		1.
1.01	11.10	134	.07	.07	.00	4.	1.01	23.40	284	.02	.02	.00		1.
1.01	11.15	135	.07	.07	.00	4.	1.01	23.45	285	.02	.02	.00		1.
1.01	11.20	136	.07	.07	.00	4.	1.01	23.50	286	.02	.02	.00		1.
1.01	11.25	137	.07	.07	.00	4.	1.01	23.55	287	.02	.02	.00		1.
1.01	11.30	138	.07	.07	.00	4.	1.02	0.00	288	.02	.02	.00		1.
1.01	11.35	139	.07	.07	.00	4.	1.02	.05	289	0.00	0.00	0.00		0.
1.01	11.40	140	.07	.07	.00	4.	1.02	.10	290	0.00	0.00	0.00		0.
1.01	11.45	141	.07	.07	.00	4.	1.02	.15	291	0.00	0.00	0.00		0.
1.01	11.50	142	.07	.07	.00	4.	1.02	.20	292	0.00	0.00	0.00		0.
1.01	11.55	143	.07	.07	.00	4.	1.02	.25	293	0.00	0.00	0.00		0.
1.01	12.00	144	.07	.07	.00	4.	1.02	.30	294	0.00	0.00	0.00		0.
1.01	12.05	145	.21	.80	.00	12.	1.02	.35	295	0.00	0.00	0.00		0.
1.01	12.10	146	.21	.20	.00	12.	1.02	.40	296	0.00	0.00	0.00		0.
1.01	12.15	147	.21	.20	.00	12.	1.02	.45	297	0.00	0.00	0.00		0.
1.01	12.20	148	.21	.20	.00	12.	1.02	.50	298	0.00	0.00	0.00		0.
1.01	12.25	149	.21	.20	.00	12.	1.02	.55	299	0.00	0.00	0.00		0.
1.01	12.30	150	.21	.20	.00	12.	1.02	1.00	300	0.00	0.00	0.00		0.
									SUM	35.37	31.81	1.16		1703.
										.822	.739	.027		39.59

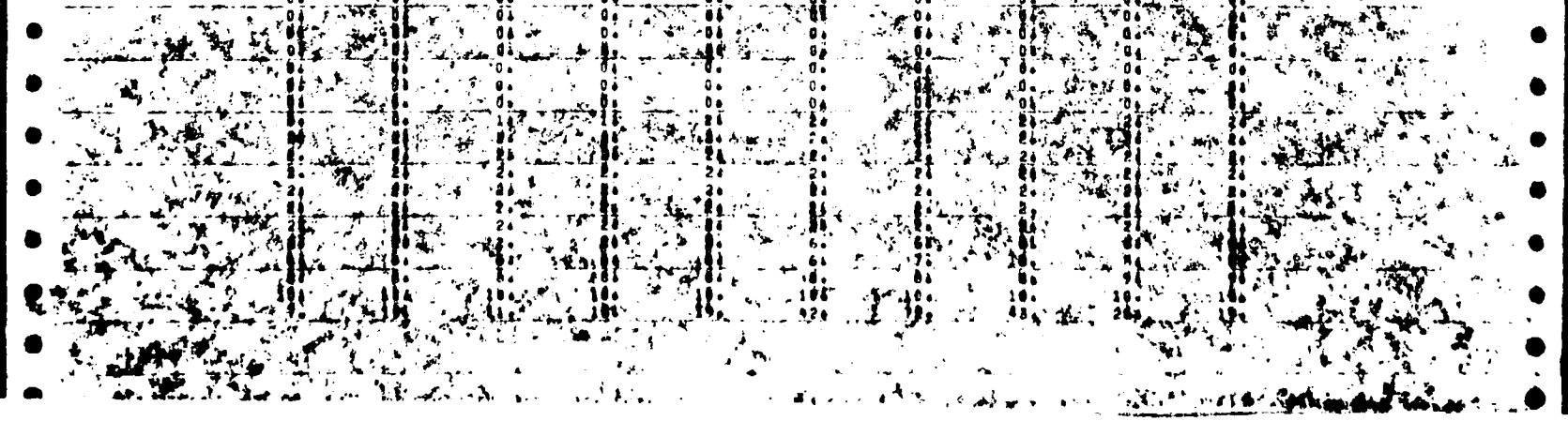
		PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
	CFS	144.	21.	7.	0.	1934.
	CMS	4.	1.	0.	0.	55.
	INCHES		.84	.71	.71	.71
	MM		21.40	18.00	18.00	18.00
	ACRE-FT		13.	4.	1.	1.
	THOUS CU M		16.	5.	1.	1.

HYDROGRAPH AT STA HUY FOR PLAN 1, RTIO 1



	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	144.	21.	1.	6.	1933.
CMS	4.	1.	0.	0.	55.
INCHES		2.769	31.81	31.81	31.81
MM		627.10	792.80	792.80	792.80
AC-FT		11.	13.	13.	13.
THOUS CU M		13.	16.	16.	16.

HYDROGRAPH AT STA HWY FOR PLAN 1, RTIO 2



15.	12.	10.	9.	9.	9.	9.	9.	9.	9.
9.	9.	9.	9.	8.	7.	7.	7.	7.	7.
7.	7.	7.	7.	7.	7.	2.	1.	1.	1.
1.	1.	1.	1.	1.	1.	1.	1.	1.	1.
1.	1.	1.	1.	1.	1.	1.	1.	1.	1.
1.	1.	1.	1.	1.	1.	1.	1.	1.	1.
1.	1.	1.	1.	1.	1.	1.	1.	1.	1.
1.	1.	1.	1.	1.	1.	1.	1.	1.	1.
1.	1.	1.	1.	1.	1.	1.	1.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	72.	11.	3.	3.	966.
CMS	2.	0.	0.	0.	27.
INCHES		12.34	15.61	15.61	15.61
MM		313.55	396.40	396.40	396.40
AC-FT		56	7.	7.	7.
THOUS CU M		6.	8.	8.	8.

COMBINE HYDROGRAPHS

COMBINE DAM OUTFLOW AND ADDITIONAL RUNOFF HYDROGRAPHS

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
HWY	2	0	0	0	0	1	0	0

SUM OF 2 HYDROGRAPHS AT HWY PLAN 1 RATIO 1

63.	61.	60.	60.	59.	58.	58.	57.	56.	56.
55.	54.	54.	53.	53.	52.	52.	51.	50.	49.
49.	49.	48.	48.	48.	47.	47.	46.	46.	45.
45.	45.	44.	44.	43.	43.	43.	42.	41.	40.
[illegible]	38.	37.	37.	36.	35.	34.	34.	33.	32.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	1613.	370.	116.	111.	33428.
CMS	46.	10.	3.	3.	947.
INCHES		22.08	27.68	27.68	27.68
MM		560.71	703.17	703.17	703.17
AC-FT		184.	230.	230.	230.
THOUS CU M		226.	284.	284.	284.

SUM OF 2 HYDROGRAPHS AT HWY PLAN 1 RTIO 2

0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1.	1.	1.	1.	1.	1.	1.	1.	1.	1.
1.	1.	1.	1.	1.	1.	1.	1.	1.	1.
1.	1.	1.	1.	1.	1.	1.	1.	1.	1.
1.	1.	2.	3.	3.	3.	3.	4.	4.	4.
4.	4.	5.	5.	5.	5.	5.	6.	6.	6.
6.	6.	7.	7.	7.	7.	7.	8.	8.	8.
8.	8.	9.	9.	9.	9.	9.	9.	10.	10.
10.	10.	10.	11.	11.	11.	11.	11.	11.	12.
12.	12.	12.	12.	12.	12.	12.	12.	12.	12.
12.	12.	12.	12.	12.	12.	12.	12.	12.	12.
12.	12.	12.	12.	15.	16.	16.	18.	16.	16.
16.	16.	16.	16.	[illegible]	[illegible]	24.	27.	29.	[illegible]
34.	37.	39.	42.	[illegible]	46.	48.	50.	54.	57.
[illegible]	62.	64.	67.	69.	75.	81.	88.	92.	97.
98.	105.	110.	128.	156.	177.	232.	266.	304.	312.
31[illegible]	308.	298.	291.	283.	276.	269.	262.	256.	250.
[illegible]	[illegible]	236.	231.	225.	219.	214.	208.	203.	199.
194.	190.	186.	183.	[illegible]	178.	167.	158.	151.	145.
136.	132.	126.	120.	114.	109.	104.	100.	95.	91.
87.	83.	79.	76.	73.	70.	67.	64.	61.	60.
[illegible]	58.	57.	[illegible]	[illegible]	[illegible]	54.	53.	52.	51.
[illegible]	[illegible]	49.	48.	[illegible]	47.	46.	45.	46.	44.
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	40.	40.	39.	39.	38.
[illegible]	[illegible]	36.	36.	[illegible]	35.	35.	34.	34.	33.
[illegible]	[illegible]	38.	38.	[illegible]	31.	30.	30.	29.	28.
[illegible]	27.	27.	26.	[illegible]	29.	[illegible]	24.	23.	23.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
CMS	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
INCHES		[illegible]	12.44	[illegible]	[illegible]
MM		[illegible]	315.08	[illegible]	315.[illegible]
AC-FT		[illegible]	[illegible]	[illegible]	[illegible]
THOUS CU M		[illegible]	[illegible]	[illegible]	[illegible]

HYDROGRAPH ROUTING

ROUTE THROUGH HWY CULVERT

ISTAG	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
HWY	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	ICPT	IEMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTOL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	815.	-1

STAGE	815.00	817.00	819.00	822.70	830.00	842.00	842.20	842.40	842.6
	843.00	845.20							
FLOW	0.0	46.00	124.00	330.00	461.00	570.00	834.00	1336.00	1984.0
	3608.0	4577.00							

SURFACE AREA=	0.	1.	2.	3.	4.	5.
CAPACITY=	0.	2.	15.	41.	48.	82.
ELEVATION=	815.	820.	830.	840.	842.	850.

CREL	SPWID	COOW	EXPW	ELEVL	COOL	CAREA	EXPL
815.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COOD	EXPD	DAMWID
842.0	0.0	0.0	0.

STATION HWY, PLAN 1, RATIO 1

END-OF-PERIOD HYDROGRAPH ORDINATES

OUTFLOW

0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	1.
1.	1.	1.	1.	1.	1.	1.	1.	1.	1.
1.	1.	1.	1.	1.	1.	1.	1.	1.	1.
2.	2.	2.	2.	2.	2.	2.	2.	2.	2.
2.	2.	2.	2.	2.	2.	3.	3.	3.	3.
3.	3.	5.	5.	6.	6.	7.	7.	8.	8.
8.	9.	9.	10.	10.	10.	11.	11.	12.	12.
12.	13.	13.	13.	14.	13.	13.	14.	14.	14.
14.	14.	14.	14.	14.	14.	14.	14.	14.	14.
14.	14.	14.	14.	14.	14.	14.	14.	14.	15.
15.	16.	18.	19.	21.	22.	24.	25.	26.	27.
28.	29.	30.	31.	32.	33.	34.	35.	36.	37.
38.	39.	40.	42.	44.	46.	48.	50.	52.	54.
56.	58.	60.	63.	66.	69.	72.	75.	78.	81.
84.	87.	90.	94.	98.	103.	108.	113.	118.	123.
128.	133.	138.	144.	150.	156.	162.	168.	175.	182.
189.	197.	205.	213.	222.	231.	240.	249.	257.	265.
272.	279.	285.	291.	297.	303.	309.	315.	321.	327.
332.	337.	341.	345.	349.	353.	357.	361.	365.	369.
373.	377.	381.	385.	389.	393.	397.	401.	405.	409.
413.	417.	421.	425.	429.	433.	437.	441.	445.	449.
453.	457.	461.	465.	469.	473.	477.	481.	485.	489.
493.	497.	501.	505.	509.	513.	517.	521.	525.	529.

518.	515.	512.	509.	505.	501.	497.	493.	489.	484.
479.	474.	469.	464.	459.	452.	446.	438.	430.	422.
412.	402.	392.	380.	368.	356.	342.	324.	275.	236.
206.	182.	163.	147.	134.	124.	117.	111.	106.	101.
95.	92.	88.	84.	81.	78.	75.	72.	69.	67.
65.	63.	61.	60.	60.	59.	58.	57.	57.	56.
56.	55.	54.	54.	53.	53.	52.	51.	51.	50.
50.	49.	49.	48.	48.	47.	47.	46.	46.	46.
45.	45.	44.	44.	44.	43.	43.	43.	42.	41.
40.	39.	38.	37.	36.	36.	35.	34.	33.	33.

STORAGE

0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	1.	1.	1.	1.	1.
1.	1.	1.	1.	1.	2.	2.	2.	2.	2.
2.	2.	3.	3.	3.	3.	3.	3.	4.	4.
4.	4.	4.	4.	4.	5.	8.	15.	23.	29.
33.	36.	37.	37.	37.	37.	36.	36.	35.	34.
33.	33.	32.	31.	30.	29.	28.	27.	26.	25.
24.	23.	22.	21.	20.	19.	18.	17.	16.	15.
14.	12.	11.	10.	8.	7.	6.	5.	4.	3.
2.	2.	1.	1.	1.	1.	1.	1.	1.	1.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

STAGE

815.0	815.0	815.0	815.0	815.0	815.0	815.0	815.0	815.0	815.0
815.0	815.0	815.0	815.0	815.0	815.0	815.0	815.0	815.0	815.0
815.0	815.0	815.0	815.0	815.0	815.0	815.0	815.0	815.0	815.0
815.0	815.0	815.0	815.0	815.0	815.0	815.0	815.0	815.0	815.0
815.0	815.0	[illegible]	815.1	815.1	815.1	815.1	815.1	815.1	815.1
815.1	815.1	[illegible]	815.1	815.1	815.1	815.1	815.1	815.1	815.1
815.1	815.1	[illegible]	[illegible]	[illegible]	[illegible]	815.1	815.1	815.1	815.1
[illegible]	815.1	[illegible]	815.2	[illegible]	[illegible]	815.3	815.3	815.3	815.4
[illegible]	815.4	[illegible]	[illegible]	815.5	815.8	815.5	815.5	815.5	815.5
[illegible]	[illegible]	[illegible]	[illegible]	815.6	[illegible]	815.6	815.6	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	815.8	[illegible]	[illegible]	815.8	[illegible]	815.6	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	816.0	816.0	816.1	816.1	[illegible]	816.2
816.?	816.3	[illegible]	816.4	[illegible]	816.6	816.6	816.6	[illegible]	816.7
816.?	816.8	816.8	816.8	817.0	817.2	817.3	817.4	817.5	[illegible]
817.?	817.8	[illegible]	[illegible]	818.3	818.5	818.8	818.8	819.0	[illegible]

819.5	819.4	819.6	819.7	819.8	819.9	820.0	820.2	820.3	820.0
820.8	820.8	820.9	821.0	821.1	821.2	821.4	821.5	821.7	821.8	821.9
828.8	827.0	828.1	822.3	822.5	823.2	823.5	827.1	832.9	835.6
837.8	838.1	838.6	838.7	838.7	838.5	838.3	838.1	837.8	837.5
837.3	837.0	836.7	836.4	836.0	835.7	835.3	834.9	834.5	834.1
833.7	833.2	832.8	832.3	831.8	831.4	830.9	830.4	829.8	829.2
828.5	827.8	827.1	826.3	825.4	824.5	823.6	822.6	821.6	821.0
820.5	820.0	819.7	819.4	819.2	819.0	818.8	818.7	818.5	818.4
818.3	818.2	818.1	818.0	817.9	817.8	817.8	817.7	817.6	817.6
817.5	817.5	817.4	817.4	817.4	817.4	817.4	817.3	817.3	817.3
817.3	817.3	817.3	817.2	817.2	817.2	817.2	817.2	817.2	817.2
817.1	817.1	817.1	817.1	817.1	817.1	817.1	817.1	817.1	817.0
817.0	817.0	817.0	817.0	817.0	817.0	817.0	816.9	816.9	816.9
816.8	816.8	816.7	816.7	816.7	816.6	816.6	816.6	816.5	816.5

PEAK OUTFLOW IS 534. AT TIME 16.17 HOURS

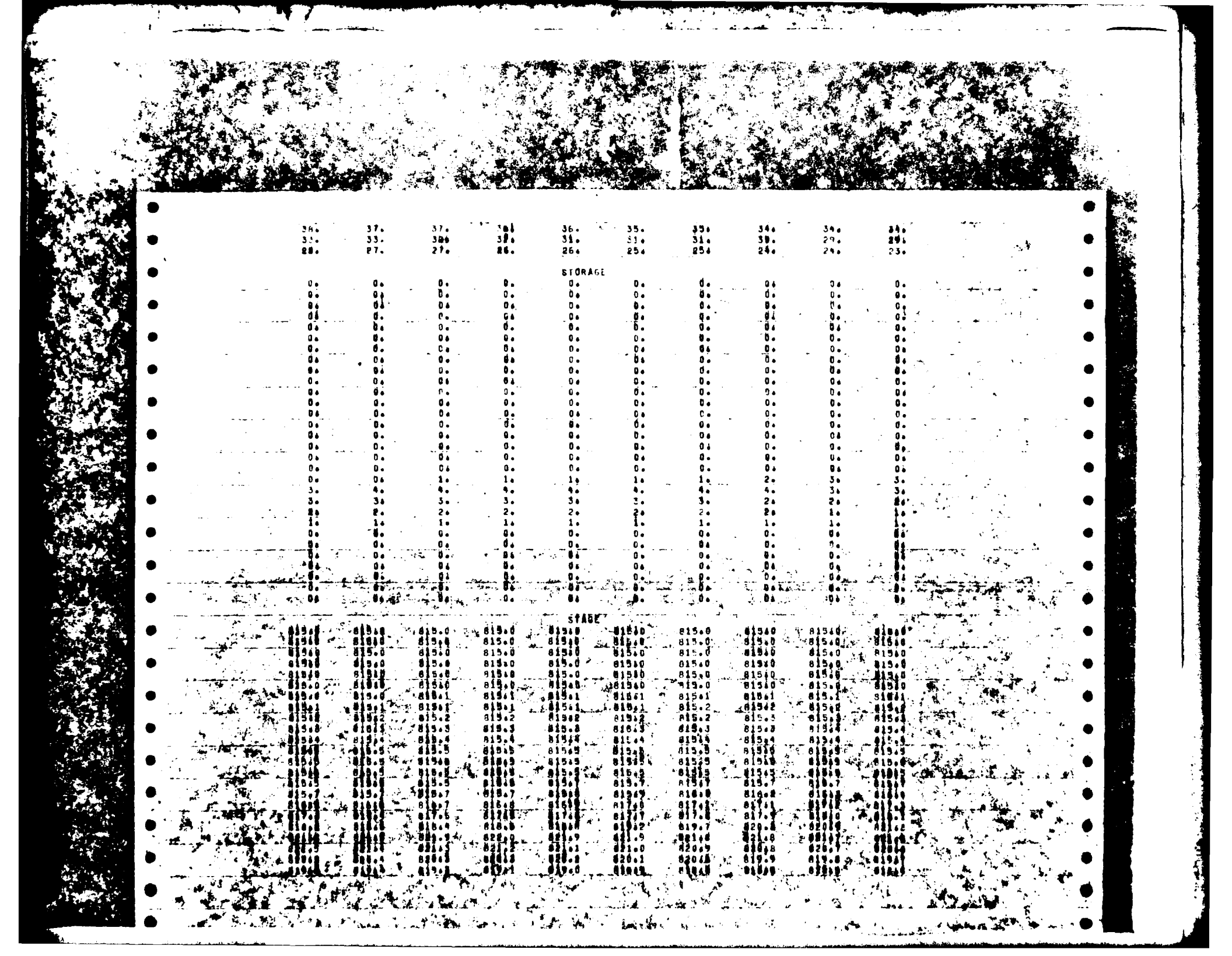
	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	534.	369.	116.	111.	33421.
CMS	15.	10.	3.	3.	946.
INCHES		22.01	27.68	27.68	27.68
MM		559.09	703.05	703.05	703.05
AC-FT		183.	230.	230.	230.
THOUS CU M		226.	284.	284.	284.

STATION HMY4 PLAN 1, RATIO 2

END-OF-PERIOD HYDROGRAPH ORDINATES

OUTFLOW

0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1.	1.	1.	1.	1.	1.	1.	1.	1.	1.
1.	1.	1.	1.	1.	1.	1.	1.	1.	1.
1.	1.	1.	1.	1.	1.	1.	1.	1.	1.
3.	3.	3.	3.	3.	3.	4.	4.	4.	4.
5.	5.	5.	5.	5.	5.	6.	6.	6.	6.
7.	7.	7.	7.	7.	7.	8.	8.	8.	8.
9.	9.	9.	9.	9.	9.	10.	10.	10.	10.
11.	11.	11.	11.	11.	11.	11.	11.	11.	11.
12.	12.	12.	12.	12.	12.	12.	12.	12.	12.
12.	12.	12.	12.	12.	12.	12.	12.	12.	12.
12.	12.	12.	15.	16.	16.	16.	16.	16.	16.
18.	18.	18.	20.	23.	25.	26.	28.	28.	28.
30.	30.	30.	44.	47.	49.	49.	82.	82.	82.
82.	82.	82.	71.	78.	80.	80.	93.	93.	93.
93.	93.	93.	116.	133.	165.	199.	228.	228.	228.
228.	228.	228.	288.	288.	282.	277.	272.	272.	272.
272.	272.	272.	240.	235.	227.	224.	218.	218.	218.
218.	218.	218.	186.	186.	181.	178.	168.	168.	168.
168.	168.	168.	126.	126.	125.	116.	109.	99.	99.
99.	99.	99.	77.	75.	78.	82.	84.	91.	91.
91.	91.	91.	56.	55.	54.	53.	53.	53.	53.
53.	53.	53.	48.	47.	46.	46.	48.	48.	48.
48.	48.	48.	41.	41.	40.	40.	39.	39.	39.


STORAGE
STAGE

818.3	818.1	818.0	817.9	817.8	817.7	817.6	817.6	817.5	817.4
817.4	817.4	817.3	817.3	817.3	817.2	817.2	817.2	817.2	817.2
817.2	817.2	817.1	817.1	817.1	817.1	817.1	817.0	817.0	817.0
817.0	817.0	816.9	816.9	816.9	816.9	816.8	816.8	816.8	816.7
816.7	816.7	816.7	816.7	816.6	816.6	816.6	816.6	816.5	816.5
816.5	816.5	816.5	816.4	816.4	816.4	816.4	816.4	816.3	816.3
816.3	816.2	816.2	816.2	816.2	816.1	816.1	816.1	816.1	816.0

PEAK OUTFLOW IS 289. AT TIME 16.17 HOURS

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	289.	158.	52.	50.	15019.
CMS	8.	4.	1.	1.	425.
INCHES		9.42	12.44	12.44	12.44
MM		239.17	315.87	315.87	315.87
AC-FT		78.	103.	103.	103.
THOUS CU M		97.	128.	128.	128.

SUMMARY OF PMF AND ONE-HALF PMF FLOOD ROUTING

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS RATIO 1 1.00	RATIO 2 .50
HYDROGRAPH AT	DAM	.19	1	2332.	1166.
	(	.38)	(	66.03)(	33.01)(
ROUTED TO	DAM	.19	1	1526.	296.
	(	.38)	(	43.22)(	8.39)(
HYDROGRAPH AT	HWY	.01	1	144.	72.
	(	.02)	(	4.08)(	2.04)(
+ COMBINED	HWY	.18	1	1613.	312.
	(	.40)	(	45.66)(	8.84)(
ROUTED TO	HWY	.18	1	534.	289.
	(	.40)	(	15.13)(	8.18)(

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 ..... b

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	815.00	815.00	842.00
STORAGE	0.	0.	48.
OUTFLOW	0.	0.	579.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
1.00	839.72	0.00	37.	534.	0.00	16.17	0.00
.50	821.95	0.00	4.	289.	0.00	16.17	0.00

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	838.00	838.00	842.00
STORAGE	104.	104.	176.
OUTFLOW	0.	0.	418.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
1.00	842.65	.65	190.	1526.	1.00	15.67	0.00
.50	841.65	0.00	169.	296.	0.00	15.92	0.00

PERCENT OF PMF FLOOD ROUTING
EQUAL TO SPILLWAY CAPACITY

REVIEW OF SEQUENCE OF STREAM NETWORK CALCULATIONS

RUNOFF HYDROGRAPH AT	DAM
ROUTE HYDROGRAPH TO	LAM
RUNOFF HYDROGRAPH AT	HWY
COMBINE 2 HYDROGRAPHS AT	HWY
ROUTE HYDROGRAPH TO	HWY
END OF NETWORK	

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FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION  JULY 1978
LAST MODIFICATION  26 FEB 79

RUN DATE= 88/07/104
TIME= 09.05.43.
```

DAM SAFETY INSPECTION - MISSOURI
HAUCK LAKE DAM MO.10989
PERCENT PMF

JOB SPECIFICATION

NO	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
300	0	5	0	0	0	0	0	-4	0

JOPER	NUT	LROPT	TRACE
5	0	0	0

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLAN= 1 NRTIO= 4 LRTIO= 1

PTIOS= .50 .62 .63 .67

SUB-AREA RUNOFF COMPUTATION

RUNOFF CALCULATIONS FOR THE MAIN DRAINAGE AREA

ISTAO	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
DAM	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDO	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	2	.15	0.00	.15	1.00	0.000	0	1	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	30.90	100.00	120.00	130.00	0.00	0.00	0.00

LOSS DATA

LROPT	STRTL	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	-1.00	-91.00	0.00	0.00

CURVE NO = 491.00 WETNESS = -1.00 EFFECT CN = 91.00

UNIT HYDROGRAPH DATA

TC= 0.00 LAG= .06

RECESSION DATA

STRTQ= 0.00 QRCSN= 0.00 RTIOR= 1.00

END-OF-PERIOD FLOW

HO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	HO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q

SUM 32.37 31.71 1.18 38764.
(822.11 793.61 29.31 1012498)

HYDROGRAPH ROUTING

ROUTE HYDROGRAPH THROUGH DAM

ISTAO	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
DAM	1	0	0	0	0	1	0	0

ROUTING DATA

RSTRK	RSTRL	ESTRK	ESTRL	DLTKR	LSTR
0.0	0.000	0.00	1	1	0	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	-830.	-1

STAGE	838.00	838.74	839.40	840.32	841.02	841.72	842.08	842.40	842.68	843.16
	843.64	844.06	844.46							
FLOW	0.00	10.00	10.00	60.00	161.00	311.00	449.00	950.00	1590.00	8095.00
	4869.00	6405.00	8189.00							
SURFACE AREA	0.	1.	6.	15.	17.	18.	21.	38.	97.	
CAPACITY	0.	1.	23.	104.	127.	137.	176.	398.	853.	
ELEVATION	820.	823.	836.	838.	839.	840.	842.	8506	860.	

CREL	SPWID	COQW	EXPW	ELEVL	COOL	CAREA	EXPL
838.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COOD	EXPD	DAMWID
842.0	0.0	0.0	0.

PEAK OUTFLOW IS 391. AT TIME 15.92 HOURS

PEAK OUTFLOW IS 448. AT TIME 15.83 HOURS

PEAK OUTFLOW IS 488. AT TIME 15.83 HOURS

PEAK OUTFLOW IS 1164. AT TIME 15.83 HOURS

SUB-AREA RUNOFF COMPUTATION

RUNOFF CALCULATIONS FOR ADDITIONAL DRAINAGE AREA

ISTAG	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
HWY	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IMTDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	2	.01	0.00	.01	1.00	0.000	0	1	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	24.90	100.00	120.00	130.00	0.00	0.00	0.00

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOR	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	-1.00	-91.00	0.00	0.00

CURVE NO = -91.00 WETNESS = -1.00 EFFECT CN = 91.00

UNIT HYDROGRAPH DATA
TC= 0.00 LAG= .09

RECESSION DATA
STRTQ= 0.00 QRCSN= 0.00 RTIOR= 1.00

END-OF-PERIOD FLOW

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
									SUM	32.37	31.21	1.16	1903.
										(822.)	793.1(	29.1(	55.89)

COMBINE HYDROGRAPHS

COMBINE DAM OUTFLOW AND ADDITIONAL RUNOFF HYDROGRAPHS

ISTAG	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
HWY	2	0	0	0	0	1	0	0

HYDROGRAPH ROUTING

ROUTE THROUGH HWY CULVERT

ISTAG	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
HWY	1	0	0	0	0	1	0	0

ROUTING DATA

ELOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	.1000	0.00	2	1	0	0	0

MSTPS	MSTOL	LAG	AMSKK	X	ITSK	STORA	ISPRAT
0	0	0	0.000	0.000	0.000	4010.	-1

FLOW	0.00	46.00	174.00	330.00	461.00	570.00	838.00	1326.00	1984.00	2746.00
	3609.00	4577.00								
SURFACE AREA=	0.	1.	2.	3.	4.	5.				
CAPACITY=	0.	8.	16.	41.	49.	82.				
ELEVATION=	819.	820.	838.	840.	842.	850.				

CREL	SPWID	COOW	EXPW	ELEVL	COOL	CAREA	EXPL
815.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COOD	EXPD	DAMWID
842.0	0.0	0.0	0.

PEAK OUTFLOW IS 388. AT TIME 16.25 HOURS

PEAK OUTFLOW IS 385. AT TIME 16.33 HOURS

PEAK OUTFLOW IS 378. AT TIME 16.33 HOURS

PEAK OUTFLOW IS 394. AT TIME 16.25 HOURS

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS RATIO 1 .58	RATIO 2 .62	RATIO 3 .63	RATIO 4 .67
HYDROGRAPH AT	DAM	.15	1	1352.	1446.	1469.	1562.
		(.38)		(38.30)	(40.94)	(41.60)	(44.24)
ROUTED TO	DAM	.15	1	397.	448.	488.	616.
		(.38)		(11.23)	(12.68)	(13.81)	(17.44)
HYDROGRAPH AT	HWY	.01	1	84.	89.	91.	97.
		(.02)		(2.37)	(2.53)	(2.57)	(2.74)
2 COMBINED	HWY	.16	1	416.	472.	518.	642.
		(.40)		(11.85)	(13.35)	(14.50)	(18.17)
ROUTED TO	HWY	.16	1	346.	365.	370.	394.
		(.40)		(9.79)	(10.33)	(10.49)	(11.15)

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	838.00	838.00	842.00
STORAGE	104.	104.	176.
OUTFLOW	0.	0.	416.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.58	841.94	0.00	175.	397.	0.00	15.92	0.00
.62	842.09	.09	178.	448.	.33	15.83	0.00
.63	842.10	.10	178.	488.	.33	15.83	0.00
.67	842.19	.19	180.	616.	.50	15.83	0.00

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 ....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	815.00	815.00	842.00
STORAGE	0.	0.	486.
OUTFLOW	0.	0.	570.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.58	823.81	0.00	6.	346.	0.00	16.25	0.00
.62	825.1[illegible]	0.00	8.	365.	0.00	16.33	0.00
.63	825.57	0.00	9.	370.	0.00	16.33	0.00
.67	827.23	0.00	11.	394.	0.00	16.25	0.00

HEC-2 INPUT AND SUMMARY TABLE

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**********************************************************
  [illegible] RELEASE [illegible]  UPDATED  JULY 197[illegible]
  ERROR CORR - [illegible]
  MODIFICATION - [illegible]
**********************************************************

NOTE- ASTERISK (*) AT LEFT OF CROSS-SECTION NUMBER INDICATES MESSAGE IN SUMMARY OF ERRORS LIST

[illegible] SPILLWAY RATIN[illegible]

[illegible] INPUT

      SECNO     DEPTH     AREA     TOPWID    [illegible]   [illegible]   [illegible]       [illegible]     10*KS     [illegible]CH

*     1.000     [illegible]  11.5[illegible]  [illegible].17  [illegible]  .[illegible]  [illegible]  44[illegible].13  174.17  30.[illegible]
*     1.000     .[illegible]  [illegible]  [illegible]  [illegible]  .[illegible]  1[illegible].00  [illegible]  14[illegible].75  30.[illegible]
*     1.000     1.[illegible]1  [illegible]  [illegible]  .1[illegible]  .[illegible]  [illegible].00  [illegible]1.[illegible]  1[illegible]  [illegible]
*     1.000     1.[illegible]  [illegible]7  44.[illegible]  [illegible]  .[illegible]  4[illegible].00  [illegible]  1[illegible]  30.[illegible]
*     1.000     2.[illegible]  71.[illegible]  [illegible]  .[illegible]9  .7[illegible]  5[illegible].00  [illegible]  117.44  30.[illegible]
*     1.000     2.[illegible]  [illegible]1  [illegible]7  7.[illegible]  .[illegible]  600.[illegible]  [illegible]  113.74  [illegible]
*     1.000     2.[illegible]  102.7[illegible]  [illegible]  7.7[illegible]  .[illegible]  [illegible]  [illegible]2.[illegible]7  1[illegible]  [illegible]
*     1.000     .[illegible]  11[illegible]  [illegible]  [illegible]  1.0[illegible]  100[illegible]  [illegible]  [illegible]  [illegible]
*     1.000     [illegible]  1[illegible].11  [illegible]  .[illegible]  1.[illegible]  1200.[illegible]  [illegible]  1[illegible]  30.00
*     1.000     3.[illegible]  1[illegible].[illegible]2  [illegible]  .[illegible]9  1.37  1400.[illegible]  [illegible]  1[illegible].24  30.[illegible]

      2.000     .[illegible]5  [illegible]  [illegible]  [illegible]  .[illegible]7  50.00  [illegible]  27.3[illegible]  30.00
      2.000     1.47     47.[illegible]0  41.1[illegible]  [illegible].18  .16  1[illegible].00  [illegible]  34.[illegible]  30.00
      2.000     2.[illegible]  73.49  48.3[illegible]  4.08  .[illegible]6  300.00  [illegible]1.72  3[illegible].23  30.00
      2.000     2.[illegible]7  [illegible].72  [illegible]  [illegible]  .31  400.0[illegible]  [illegible]  4[illegible].48  30.00
      2.000     2.64     104.50  [illegible]50  4.[illegible]1  .36  500.00  842.4[illegible]  4[illegible].79  30.0[illegible]
      2.000     .[illegible]7  11[illegible].65  55.[illegible]  [illegible].14  .41  [illegible]  [illegible]2.6[illegible]  [illegible].[illegible]1  30.[illegible]
      2.000     [illegible].26  1[illegible].6[illegible]  [illegible]  [illegible].81  .5[illegible]  800.0[illegible]  [illegible]418  4[illegible]  30.[illegible]
      2.000     [illegible]  155.4[illegible]  55.00  [illegible]  .[illegible]  1000.0[illegible]  [illegible]3.64  47.7[illegible]  30.0[illegible]
      2.000     [illegible]  17[illegible]  55.[illegible]  [illegible]  .74  1200.00  [illegible]  44.95  30.00
      2.000     4.[illegible]  190.[illegible]  [illegible]  7.[illegible]  .84  1400.00  844.4[illegible]  46.05  30.[illegible]

---SUMMARY OF ERRORS---

CAUTION SECNO= 1.000 PROFILE= 1 CRITICAL DEPTH ASSUMED
CAUTION SECNO= 1.000 PROFILE= 2 CRITICAL DEPTH ASSUMED
CAUTION SECNO= 1.000 PROFILE= 3 CRITICAL DEPTH ASSUMED
CAUTION SECNO= 1.000 PROFILE= 4 CRITICAL DEPTH ASSUMED
CAUTION SECNO= 1.000 PROFILE= 5 CRITICAL DEPTH ASSUMED
CAUTION SECNO= 1.000 PROFILE= 6 CRITICAL DEPTH ASSUMED
CAUTION SECNO= 1.000 PROFILE= 7 CRITICAL DEPTH ASSUMED
CAUTION SECNO= 1.000 PROFILE= 8 CRITICAL DEPTH ASSUMED
CAUTION SECNO= 1.000 PROFILE= 9 CRITICAL DEPTH ASSUMED
CAUTION SECNO= 1.000 PROFILE=10 CRITICAL DEPTH ASSUMED
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DATE
IL ME